Complete Summary

GUIDELINE TITLE

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS).

BIBLIOGRAPHIC SOURCE(S)

Institute for Clinical Systems Improvement (ICSI). Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2008 Oct. 69 p. [138 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2006 Oct. 76 p.

** REGULATORY ALERT **

FDA WARNING/REGULATORY ALERT

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- December 3, 2008, Innohep (tinzaparin): The U.S. Food and Drug Administration (FDA) has requested that the labeling for Innohep be revised to better describe overall study results which suggest that, when compared to unfractionated heparin, Innohep increases the risk of death for elderly patients (i.e., 70 years of age and older) with renal insufficiency. Healthcare professionals should consider the use of alternative treatments to Innohep when treating elderly patients over 70 years of age with renal insufficiency and deep vein thrombosis (DVT), pulmonary embolism (PE), or both.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

- Chest pain/discomfort, including coronary artery disease (CAD) and non-cardiac causes
- Acute coronary syndrome
- Acute myocardial infarction
- ST-elevation myocardial infarction
- Acute myocardial infarction complications

GUIDELINE CATEGORY

Diagnosis
Evaluation
Management
Rehabilitation
Risk Assessment
Screening
Treatment

CLINICAL SPECIALTY

Cardiology
Critical Care
Emergency Medicine
Family Practice
Internal Medicine
Surgery

INTENDED USERS

Advanced Practice Nurses
Allied Health Personnel
Emergency Medical Technicians/Paramedics
Health Care Providers
Health Plans
Hospitals
Managed Care Organizations
Nurses
Physician Assistants
Physicians

GUIDELINE OBJECTIVE(S)

- To increase the success of emergency intervention for patients with high-risk chest pain
- To minimize the delay in administering thrombolytics or angioplasty to patients with acute myocardial infarction
- To increase the timely initiation of treatment to reduce postinfarction mortality in patients with acute myocardial infarction
- To increase the percentage of patients with acute myocardial infarction, who have used tobacco products within the past year, who receive tobacco cessation advice and counseling during the hospital stay
- To increase the percentage of patients with acute myocardial infarction using appropriate cardiac rehabilitation post-discharge

TARGET POPULATION

Adults greater than age 18 years presenting with past or present symptoms of chest pain, discomfort, and/or indications of acute coronary syndrome

INTERVENTIONS AND PRACTICES CONSIDERED

Screening/Evaluation/Diagnosis/Risk Assessment

1. Initial evaluation by triage
2. Medical history, physical examination, and risk assessment
3. Clinic evaluation depending on symptoms and risk factors
4. Vital signs assessment
5. Electrocardiogram
6. Cardiac markers (troponin T or I, creatine kinase MB)
7. Diagnostic coronary angiography
8. Treadmill stress test
9. Computed tomography angiogram, echocardiogram/transesophageal echocardiography, magnetic resonance imaging, arterial blood gases, chest x-ray if indicated

Management/Treatment/Rehabilitation

1. Emergency interventions including ambulance transport to Emergency Department, immediate assessment with cardiac monitoring, initial management according to the American Heart Association Advanced Cardiac Support guideline
2. Early therapy (e.g., intravenous access, oxygen, aspirin, nitroglycerin, morphine)
3. Percutaneous coronary intervention or coronary artery bypass graft if indicated
4. Thrombolytics
5. Treatment of acute myocardial infarction complications
6. Phase 1 cardiac rehabilitation including aspirin, clopidogrel, beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, calcium channel blockers, oral nitrates, enoxaparin, warfarin, oral antiarrhythmics, statins, tobacco cessation, and glycemic control
7. Phase 2 cardiac rehabilitation (outpatient management) including education, risk factor modifications, treatment of depression, and exercise prescription
8. Phase 3 and 4 cardiac rehabilitation (maintenance)

9. Follow-up

MAJOR OUTCOMES CONSIDERED

- Diagnostic value of tests
- Prognostic value of risk assessment interventions
- Effectiveness of secondary prevention, treatment, and rehabilitation interventions on reducing mortality and morbidity rates
- Positive predictive value of new ST elevation

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

A literature search of clinical trials, meta-analysis, and systematic reviews is performed.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Classes of Research Reports:

A. Primary Reports of New Data Collection:

Class A:

- Randomized, controlled trial

Class B:

- Cohort study

Class C:

- Non-randomized trial with concurrent or historical controls
- Case-control study
- Study of sensitivity and specificity of a diagnostic test

- Population-based descriptive study

Class D:

- Cross-sectional study
- Case series
- Case report

B. Reports that Synthesize or Reflect upon Collections of Primary Reports:

Class M:

- Meta-analysis
- Systematic review
- Decision analysis
- Cost-effectiveness analysis

Class R:

- Consensus statement
- Consensus report
- Narrative review

Class X:

- Medical opinion

METHODS USED TO ANALYZE THE EVIDENCE

Review of Published Meta-Analyses
Systematic Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Guideline Development Process

Each guideline, order set, and protocol is developed by a 6- to 12-member work group that includes physicians, nurses, pharmacists, other healthcare professionals relevant to the topic, along with an Institute for Clinical Systems Improvement (ICSI) staff facilitator. Ordinarily, one of the physicians will be the leader. Most work group members are recruited from ICSI member organizations,

but if there is expertise not represented by ICSI members, one or two members may be recruited from medical groups or hospitals outside of ICSI.

The work group meets for seven to eight three-hour meetings to develop the guideline. A literature search and review is performed and the work group members, under the coordination of the ICSI staff facilitator, develop the algorithm and write the annotations and footnotes and literature citations.

Once the final draft copy of the guideline is developed, the guideline goes to the ICSI members for critical review.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

The guideline developers reviewed published cost analyses.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Critical Review Process

Every newly developed guideline or a guideline with significant change is sent to Institute for Clinical Systems Improvement (ICSI) members for Critical Review. The purpose of critical review is to provide an opportunity for the clinicians in the member groups to review the science behind the recommendations and focus on the content of the guideline. Critical review also provides an opportunity for clinicians in each group to come to consensus on feedback they wish to give the work group and to consider changes necessary across systems in their organization to implement the guideline.

All member organizations are expected to respond to critical review guidelines. Critical review of guidelines is a criterion for continued membership within ICSI.

After the critical review period, the guideline work group reconvenes to review the comments and make changes, as appropriate. The work group prepares a written response to all comments.

Approval

Each guideline, order set, and protocol is approved by the appropriate steering committee. There is one steering committee each for Respiratory, Cardiovascular, Women's Health, and Preventive Services. The Committee for Evidence-based Practice approves guidelines, order sets, and protocols not associated with a particular category. The steering committees review and approve each guideline based on the following:

- Member comments have been addressed reasonably.
- There is consensus among all ICSI member organizations on the content of the document.
- To the extent of the knowledge of the reviewer, the scientific recommendations within the document are current.
- Either a critical review has been carried out, or to the extent of the knowledge of the reviewer, the changes proposed are sufficiently familiar and sufficiently agreed upon by the users that a new round of critical review is not needed.

Once the guideline, order set, or protocol has been approved, it is posted on the ICSI Web site and released to members for use. Guidelines, order sets, and protocols are reviewed regularly and revised, if warranted.

Revision Process of Existing Guidelines

ICSI scientific documents are revised every 12 to 36 months as indicated by changes in clinical practice and literature. Every 6 months, ICSI checks with the work group to determine if there have been changes in the literature significant enough to cause the document to be revised earlier than scheduled.

Prior to the work group convening to revise the document, ICSI members are asked to review the document and submit comments. During revision, a literature search of clinical trials, meta-analysis, and systematic reviews is performed and reviewed by the work group. The work group meets for 1-2 three-hour meetings to review the literature, respond to member organization comments, and revise the document as appropriate.

If there are changes or additions to the document that would be unfamiliar or unacceptable to member organizations, it is sent to members to review prior to going to the appropriate steering committee for approval.

Review and Comment Process

ICSI members are asked to review and submit comments for every guideline, order set, and protocol prior to the work group convening to revise the document.

The purpose of the Review and Comment process is to provide an opportunity for the clinicians in the member groups to review the science behind the recommendations and focus on the content of the order set and protocol. Review and Comment also provides an opportunity for clinicians in each group to come to consensus on feedback they wish to give the work group and to consider changes needed across systems in their organization to implement the guideline.

All member organizations are encouraged to provide feedback on order sets and protocol, however responding to Review and Comment is not a criterion for continued membership within ICSI.

After the Review and Comment period, the work group reconvenes to review the comments and make changes as appropriate. The work group prepares a written response to all comments.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Note from the National Guideline Clearinghouse (NGC) and the Institute for Clinical Systems Improvement (ICSI): For a description of what has changed since the previous version of this guidance, refer to Summary of Changes Report-- October 2008.

The recommendations for diagnosis and treatment of chest pain and acute coronary syndrome (ACS) are presented in the form of 7 algorithms with 127 components, accompanied by detailed annotations. Algorithms are provided for: Chest Pain Screening; Emergency Intervention; ST-Segment Elevation Myocardial Infarction (STEMI); Acute Myocardial Infarction Complications; Special Work-Up; Non-Cardiac Causes; and Clinic Evaluation. Clinical highlights and selected annotations (numbered to correspond with the algorithm) follow.

Class of evidence (A-D, M, R, X) definitions are provided at the end of the "Major Recommendations" field.

Clinical Highlights

- On initial contact with the health care system, high-risk patients need to be identified quickly and referred to an emergency room via the 911 system. (*Annotations #1-7*)
- Patients whose chest pain symptoms are suggestive of serious illness need immediate assessment in a monitored area of the emergency room and early therapy to include an intravenous access, oxygen, aspirin, nitroglycerin, and morphine. (*Annotations #20 and 25*)
- Triage and management of patients with chest pain and unstable angina must be based on a validated risk assessment system. (*Annotation #27*)
- Patients with high-risk features need to be identified quickly and treatment instituted in a timely fashion. (*Annotations #27-31*)
- Patients with low-risk symptoms should be evaluated as outpatients in a timely fashion. (*Annotations #27, 36, 37*)
- Treadmill test results should be reported using the Duke treadmill score, based on the Bruce protocol. (*Annotations #97-103, 107, 111, 115*)
- Thrombolysis should be instituted within 30 to 60 minutes of arrival, or angiogram/primary percutaneous coronary intervention should be performed within 90 minutes of arrival with a target of less than 60 minutes. (*Annotations #43, 45*)
- Use of medication: aspirin and clopidogrel (Plavix®) (or clopidogrel alone if aspirin allergic) at admission. (Avoid clopidogrel if cardiac surgery is anticipated.) Beta-blockers whenever possible and/or angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blockers at 24 hours if stable, nitrates (when indicated), and statins whenever possible. Once the issue of surgery is clarified, consider the early use of clopidogrel for those in whom percutaneous coronary intervention is planned. (*Annotations #25, 48, 65*)
- Recommend appropriate use of cardiac rehabilitation post-discharge. (*Annotations #63, 65*)

Chest Pain Screening Algorithm Annotations

1. **Initial Contact with Complaint of "Chest Pain/Discomfort" in Person or via Telephone**

   Initial presentation may be in person or on the phone, etc.

   Definitions:

   > Chest: Upper abdomen, chest, upper back, throat, jaw, shoulders, upper arms.
   >
   > Pain: "Discomfort" or other abnormal sensation such as "gas," "indigestion," "fullness," "pressure," "tightness," or "heaviness." *[R]*

2. **Initial Evaluation by Triage Indicates Elevated Risk?**

   Key Points:

   - The purpose of triage is to avoid delay in the identification of acute coronary syndromes, not to diagnose common, non-emergent causes of chest pain.

   Triage should move patients with suspicious symptoms forward (especially diabetic and middle-aged or older) to immediate electrocardiogram and prompt clinician assessment (with expedited cardiac enzymes if appropriate). Triage staff should be systematically trained to recognize chest pain and cardiovascular risk indicators.

   Reception and other staff should bring all complaints of chest pain and breathlessness to medical personnel for further evaluation, especially when:

   - The patient is currently having symptoms.
   - The interviewer senses distress.
   - Symptoms have been present for less than eight weeks (or are getting worse).
   - The patient feels the pain was at least moderate.
   - There are other symptoms of ill health (e.g., shortness of breath, weakness, sweating, nausea).
   - The patient requests an immediate opportunity to discuss the symptoms with medical personnel.

   [D]

4. **Brief Screening History by Medical Personnel**

   Key Points:

- Teach medical triage personnel to appropriately conduct the brief screening history, paying particular attention to presence of high-risk symptoms.

Angina, typical angina, atypical angina, atypical chest pain, and non-cardiac chest pain are not consistently defined and used in medical practice. Sometimes they are used to describe a symptom complex; at other times they are used to describe an etiology. For the purposes of this guideline, the following definitions will be used to categorize the patient's chest pain or discomfort as a symptom complex and not an etiology:

> **Typical angina** - pain or discomfort that is 1) substernal, 2) provoked by exercise and/or emotion, and 3) relieved by rest and/or nitroglycerine.
>
> **Atypical angina** - pain or discomfort that has two of the three features listed for typical angina.
>
> **Nonanginal chest pain** - pain or discomfort that has one or none of the three features listed for typical angina.

It should be emphasized that patients with non-anginal chest pain may still be at risk for acute myocardial infarction or acute coronary syndrome. Several serious illnesses are included in the differential diagnosis of chest pain. Assessment of these illnesses requires office or emergency department evaluation. The initial phone interview is limited to determining the timing and location of the initial office or emergency room evaluation.

The risk of immediate adverse outcome is a function of the time course of the chest pain. If the symptoms have been stable for more than two weeks, the risk of an immediate adverse outcome is low. The phone history should stress symptoms suggestive of life-threatening illnesses and the time course of the symptoms.

High-Risk Symptoms

Symptoms suggestive of a high risk of immediate adverse outcome include, but are not limited to:

- Severe or ongoing pain
- Pain lasting 20 minutes or more
- New pain at rest or with minimal activity
- Severe dyspnea
- Loss of consciousness

[R]

The interviewer may use his/her discretion with respect to the need to obtain further history for such symptoms or refer to a physician.

All patients with high-risk chest pain symptoms should be instructed on the proper use of 911.

The interviewer must use his or her judgment. This guideline focuses on serious complaints that the interviewer feels may signify a serious illness. Chest pain that is not high risk in the judgment of the interviewer (e.g., a young person with chest wall pain) may be evaluated in the office.

Teach medical triage personnel to appropriately conduct the brief screening history.

5. **High-Risk Symptom(s) Present at Time of Call**

   Call 911.

6. **High-Risk Symptom(s) Present Within Last Two Days**

   Patients who have had high-risk symptom(s) within the previous two days are at the highest risk and should enter the 911 system. The interviewer may judge the need for ambulance transport and office or emergency room evaluation for patients who call hours or days after transient symptoms resolve.

8. **High-Risk Symptom(s) Present Between Three Days and Last Two Weeks**

   Patients who have had high-risk symptom(s) within the previous two weeks but not the previous two days may be safely evaluated in either a properly equipped office or the emergency room.

10. **High-Risk Symptom(s) Present Between Two Weeks and Two Months**

    High-risk symptom(s) within two months of the initial evaluation but not within two weeks identify a group of patients at lower risk for immediate adverse outcome. These patients can be evaluated in the office within three days.

11. **Clinic Evaluation Within 72 Hours**

    Patient education directed toward use of 911 and recognition of signs and symptoms of an advancing coronary event should occur at this point.

12. **High-Risk Symptom(s) Present More than Two Months Ago**

    Patients who have been stable without high-risk symptoms for the previous two months can be seen as a routine appointment.

13. **Elective Clinic Evaluation (Within Two Weeks)**

Patient education directed toward use of 911 and recognition of signs and symptoms of an advancing coronary event should occur at this point.

14. **Urgency Uncertain**

    If the severity and/or duration of the chest pain symptoms cannot be determined in the phone interview, the patient should be seen on the same day in the office or the emergency room.

Emergency Intervention Algorithm Annotations

19. **Ambulance Transport to Emergency Department**

    A patient complaining of chest pain suggestive of serious etiology should be transported via ambulance with advanced cardiac life support capabilities whether he/she is being transported from home or outpatient clinic to the emergency room.

    Patients who are critically ill or unstable should be taken to a hospital capable of performing cardiac catheterization and cardiac surgery unless this would lead to excessive transport time. Plans for triage of a critically ill patient to a tertiary care institution should be part of every community hospital plan.

    If a patient is seen in a clinic or physician's office complaining of chest pain suggesting a serious condition, the patient must be transported to the emergency room as soon as possible. Attempts should be made to stabilize the patient as well as possible prior to transport. The referring physician must call the receiving physician and send copies of all medical records pertaining to the current illness.

    [B], *[R]*

20. **Immediate Assessment with Cardiac Monitoring**

    On arrival in the emergency room, a patient complaining of chest pain should immediately receive oxygen via nasal cannula, and a 324 mg loading dose of aspirin, preferably chewed (for patient palatability, use four 81 mg baby aspirin tablets). An immediate electrocardiogram should be done and the physician called for as the patient is placed on a cardiac monitor. Intravenous access should be obtained as soon as possible and cardiac markers drawn. Troponin I or T has been proven to be very sensitive and specific for myocardial injury as well as predictive of short-term risk for myocardial infarction or death *[X]*. Creatine kinase MB band should no longer be used as the primary marker for myocardial infarction, but can be useful in assessing the timing of the event The use of troponin can present diagnostic challenges in subgroups of patients where it may be chronically elevated or when the initial troponin measure and a subsequent measure both reflect tiny elevations of the biomarker in the setting of non-ischemic cardiac conditions. It is appropriate to measure serial troponin values during the initial six (6) hours of observation and look for a significant rise and/or fall (delta) in the troponin measure. A diagnosis of acute coronary syndrome can be established

when the change in troponin value is significant in the appropriate clinical setting. A significant delta requires a change of approximately three times the coefficient of variation (COV) of the measurement being made from the troponin assay being utilized. The range of the COV will vary depending on whether the troponin value is at the range of the lower limit of detection or is more significantly elevated initially. The definition of a significant delta is best determined by having the laboratory report the change (delta) as "significant" or "non-significant" and thus requires close collaboration with the hospital laboratory physicians. As with any diagnostic test, the interpretation of an abnormal serum troponin (or creatine kinase-MB) is dependent upon the clinical setting in which the myocardial injury occurred. While tiny elevations of troponin are of prognostic importance, the diagnosis of acute myocardial infarction requires a significant rapid rise and/or subsequent fall (Delta) to baseline in the appropriate clinical setting. It also must be recognized that many non-ischemic cardiac conditions are associated with tiny troponin deltas as well as chronic troponin elevations. These elevations, while of prognostic importance, may not reflect acute ischemic cardiac injury. Interpretation of an abnormal serum troponin (or creatine kinase-MB) is dependent upon the clinical setting in which the myocardial injury occurred. B-type natriuretic peptide may be of value in assessing cardiac function. A portable chest x-ray may be performed if indicated. The emergency room physician should also be called to the patient's bedside immediately.

On arrival, the physician should perform a brief initial assessment based on vitals, brief historical information, and physical examination. Institution of stabilizing therapy (including chewable aspirin, nitroglycerin, and morphine for suspect anginal pain) prior to completing history or physical is appropriate and often necessary at this level.

[B], *[R]*

21. **Vital Signs Compromised?**

    In the critically ill patient whose vitals are compromised (i.e., cardiac arrest, tachyarrhythmias, severe bradycardia, shock, or hypotension); the Advanced Cardiac Life Support guideline developed by the American Heart Association should be followed *[B]*, *[R]*.

22. **Initiate Advanced Cardiac Life-Support Protocols**

    The Consolidated Omnibus Budget Reconciliation Act (COBRA) of 1987, 1989, and 1990 places strict requirements and restrictions on initial assessment and transfer of patients with emergency medical conditions and women in labor *[B]*, *[R]*.

    The American Heart Association Advanced Cardiac Life Support guideline provides the most recent protocols for initial management of patients whose vital signs are compromised.

23. **Symptoms Suggest Possibility of an Acute Coronary Syndrome?**

The symptoms that suggest acute coronary syndrome are, in order of importance:

1. Chest pain description (See Annotation #4 above, "Brief Screening History by Medical Personnel")
2. History or evidence of ischemic heart disease
3. Age, gender, comorbidities (atypical presentation in female, elderly, and diabetic)
4. Presence of cardiac risk factors

The description of the patient's chest pain or discomfort is the most critical part of the history. Although multiple other features of the chest pain may be incorporated into an experienced clinician's judgment, the clinician should ultimately attempt to classify the patient as having typical angina, atypical angina, or nonanginal chest pain as described in Annotation #4, "Brief Screening History by Medical Personnel" of the Chest Pain Screening algorithm.

24. **Electrocardiogram Positive for ST-Segment Elevation?**

Key Points:

- An electrocardiogram should be obtained immediately upon arrival in the emergency room.

The recognition of coronary artery disease and evaluation of its severity cannot be adequately carried out without an electrocardiogram. The early performance of an electrocardiogram following arrival at the emergency department is therefore critical. When patients have new or presumably new ST elevation of greater than 1 mm in two or more contiguous limb leads, or equal to 2 mm or more in precordial leads, they should be considered to have acute myocardial infarction. Patients with new or presumably new left bundle branch block should be treated similarly to those with ST-segment elevation. Although some patients with left bundle branch block will prove not to have acute myocardial infarction, thrombolytic therapy of patients with left bundle branch block is nevertheless associated with a reduction in patient mortality.

Regardless of ST elevation, consider cardiology consultation early.

25. **Early Therapy**

Key Points:

- Patients whose chest pain symptoms are suggestive of serious illness need immediate assessment in a monitored area of the emergency room and early therapy to include an intravenous access, oxygen, aspirin, nitroglycerin, and morphine *[A]*.
- Early therapy may consist of aspirin, heparin or enoxaparin, nitrates, beta blockers, and clopidogrel, a glycoprotein (GP) IIb/IIIa receptor antagonist.

Aspirin reduces mortality, reinfarction, and stroke. Although the incremental value of heparin/enoxaparin in conjunction with aspirin and reperfusion therapy is controversial, it does appear to enhance patency, and was included in the GUSTO protocol. In eligible patients, beta-blockers reduce mortality, reinfarction, and stroke. Although long-acting nitrates (oral and intravenous) appeared to reduce mortality in trials that did not include thrombolysis, more recent studies that did include thrombolysis found no incremental benefit from nitrate therapy. Nitrate therapy is still appropriate for ischemic pain relief.

All patients should receive aspirin (chewable) as soon as possible and continued indefinitely. In those patients who are unable to take aspirin, clopidogrel should be considered. If the probability of urgent coronary artery bypass graft is low, consider early use of clopidogrel. The benefits of beta-blockers, nitroglycerin, and heparin are well established. There is data to support the use of enoxaparin as an alternative to intravenous heparin.

In high-risk patients, early administration of subcutaneous low-molecular-weight heparin (enoxaparin 1 mg/kg subcutaneous every 12 hours) or intravenous unfractionated heparin (70 units/kg load then 12 to 15 units/kg/hr to achieve partial thromboplastin time levels of 1.5 to 2.5 times the control), with aspirin and/or clopidogrel is associated with a decrease in the incidence of acute myocardial infarction and ischemia.

Enoxaparin has been shown to have a moderate benefit over intravenous access heparin in decreasing the rate of death, myocardial infarction, and recurrent ischemia. A meta-analysis of the two trials showed a statistically significant reduction by 20% in the rate of death and myocardial infarction *[A]*.

Enoxaparin should be used with caution in patients with renal insufficiency.

The recently completed SYNERGY study found increased adverse events in patients that were switched from unfractionated heparin to enoxaparin or vice versa at the time of referral to tertiary care institutions. Therefore, the suggestion is that the patient be started and maintained on one drug or the other during transfer and treatment at referring and referral institutions *[A]*.

Beta-blockers have been a cornerstone of acute coronary syndrome therapy. A recent large trial, the Chinese Cardiac Study 2 (CCS2), also called the Clopidogrel and Metoprolol for Myocardial Infarction Trial (COMMIT) *[A],* demonstrated no overall benefit from early administration of intravenous metoprolol in ST-elevation myocardial infarction patients receiving medical therapy +/- thrombolysis. In this population with no primary or delayed angioplasty, post-hoc analysis revealed a survival advantage with reduced ventricular tachycardia/ventricular fibrillation if the presenting systolic blood pressure was over 120 mm Hg, no benefit if the blood pressure was 100 to 120 mm Hg, and significant mortality attributed to the development of cardiogenic shock if the blood pressure was under 100 mm Hg. Caution in administering intravenous beta-blocker is advised until after revascularization and stabilization of the patient's blood pressure. Intravenous beta-blocker should be avoided in Killip III/IV patients. Hypertensive and tachycardic

patients may benefit from early ancillary intravenous beta-blocker therapy *[R]*. Beta-blocker therapy remains indicated for non ST-segment elevation myocardial infarction and unstable angina unless hypotension, shock, heart block or other contraindication is present.

Beta-blockers should be initiated early in the absence of any contraindications. In high-risk patients, they should be given initially by intravenous access, followed by the oral route with a goal target resting heart rate of 50 to 60 beats per minute. Patients with low to intermediate risk may start out with oral therapy. The duration of benefit is uncertain. A meta-analysis of double-blinded randomized trials in patients with evolving myocardial infarction showed a 13% reduction in risk progression to acute myocardial infarction. Other multiple randomized trials in coronary artery disease patients have shown a decrease in mortality and/or morbidity rates.

Beta-blockers should be used in most patients with ST-segment elevation myocardial infarction. They remain underutilized in patients with chronic obstructive pulmonary disease and diabetes mellitus where definite benefit has been demonstrated. Beta-blockers are relatively contraindicated in patients with asthma and hypotension, less so with first degree atrioventricular block, heart rate less than 60/minute, or decompensated congestive heart failure. They should be used cautiously, if at all in these conditions. They should be completely avoided in ST-segment elevation myocardial infarction due to cocaine use because of the risk of exacerbating coronary spasm, and in patients with cardiogenic shock *[A]*.

Nitroglycerin should be given sublingually (0.4 mg every five minutes) to relieve ischemic symptoms. If symptoms are ongoing or recurrent despite the administration of intravenous access beta-blockers, intravenous access nitroglycerin can be initiated at 10 mcg/min and titrated every 3 to 5 minutes by 10 mcg/min until symptom response is noted or blood pressure decreases to less than 110 mm Hg in patients previously normotensive or by 25% in patients who were hypertensive on presentation, or to a maximum dose of 200 mcg/min. Patients can be converted to topical or oral nitrates once stabilized (no manifestations of ischemia and pain free for 12 to 24 hours).

ISIS-4 and GISSI-3 failed to show a benefit of nitroglycerin on reduction of mortality in acute myocardial infarction.

Nitroglycerin is contraindicated in patients who are hypotensive, have documented severe aortic stenosis, have hypertrophic cardiomyopathy, or who have received sildenafil, vardenafil, or ordenafil within the previous 24 hours or tadalafil in the previous 48 hours *[R]*.

GPIIb/IIIa Inhibitors

Patients with high risk or patients with intermediate risks and diabetes as defined in Annotation #27 "Risk Assessment," benefit from receiving GP IIb/IIIa inhibitor (tirofiban HCl, abciximab, or eptifibatide) as part of initial treatment.

An early invasive strategy involves diagnostic catheterization within 24 to 48 hours, followed by percutaneous coronary intervention or coronary artery bypass graft if warranted.

Contraindications to IIb/IIIa inhibitors include bleeding less than six weeks, intracranial hemorrhage (ever), recent stroke less than two years, uncontrolled hypertension greater than 200/100 mm Hg, surgery less than six weeks, aortic dissection, acute pericarditis, and platelets less than 100,000 mm^3.

[A], *[M]*, *[R]*

27. **Risk Assessment**

Key Points:

- Medical groups and hospitals should implement a validated risk assessment criteria set systemwide.

There is a variety of risk assessment criteria for patients presenting with chest pain and suspected acute coronary syndrome. This section will focus on risk assessment for chest pain symptoms and subsequent risk assessment for those with suspected or documented acute coronary syndrome.

Chest Pain Risk Assessment

The Agency for Health Care Policy and Research (AHCPR currently known as the Agency for Healthcare Research and Quality) criteria are probably the best validated tool for assessment of chest pain and the likelihood of reflecting high risk or unstable coronary artery disease. Patients who are deemed low risk by AHCPR criteria may be safely evaluated as outpatients. These will include some patients with slight progression of their symptoms, which may reflect non-compliance with medications, increasing activity, emotional stress or other exacerbating factors. Patients with a low likelihood of coronary artery disease on the basis of chest pain description, age, gender and risk factor assessment, and patients at intermediate likelihood who have not had at-rest symptoms that are prolonged or accompanied by shortness of breath or other worrisome features should also be considered stable.

Patients who are intermediate risk by AHCPR criteria need definitive emergency department assessment and may be most suitable for admission to an observation or chest pain unit. Patients with intermediate risk symptoms should undergo risk stratification with assessment of cardiac biomarkers, repetitive electrocardiograph assessment and ultimately cardiac imaging and stress testing.

Patients who fulfill high-risk AHCPR criteria should be admitted to hospital and most likely will represent unstable coronary disease. A large number of studies have confirmed this risk and support a strategy of hospitalization and subsequent risk assessment for acute coronary syndrome *[A]*.

Complete certainty of the etiology of a patient's chest pain is difficult to achieve by an evaluation and can commonly not be attained in the emergency room. It is therefore vitally important to assess risk in order to safely and yet cost-effectively triage chest pain patients. Further, it is important to recognize the difference between risk assessment and likelihood assessment in that likelihood assessment merely serves to communicate just that, while risk assessments may be used as a tool for clinical management. It is also appropriate to incorporate appropriate follow-up testing and referral to a cardiovascular specialist as part of ongoing risk assessment in patients and the emergency department strategy for evaluation.

For patients with unstable coronary artery disease and/or an acute coronary syndrome, it is important to use objective risk assessment criteria for purposes of triage (critical care unit, monitored bed or immediate catheterization lab referral). There are a number of ways to risk stratify patients with unstable coronary disease. The initial examination in the emergency department often provides insight into the patient's risk. An astute clinician can often assess risk from the physical examination and laboratory assessment.

Patients who present with elevated jugular venous pressure (JVP) and rales represent high-risk acute coronary syndrome subsets. Those who present with Killip class II (elevated JVP and rales less than 50% of the lung field) and Killip class III (rales greater than 50% of the lung fields) have significantly higher mortality risks than those with Killip Class I (normal lung exam and JVP). Additionally, those who present with greater than 1 mm ST depression on the electrocardiogram reflect a higher risk subset of acute coronary syndrome patients, often because ST depression of this magnitude reflects multivessel coronary artery disease. Patients with acute coronary syndrome who present with moderate to severe renal insufficiency represent a very high risk subset of patients and have significantly elevated short- and long-term mortality risks. Finally, those who present with an elevated plasma glucose (greater than 150 mg/dL), independent of a diagnosis of diabetes, represent a subset with increased in-hospital mortality risks.

There are a number of risk assessment scores or tools that can be utilized to assess patients with suspected or definite acute coronary syndrome. Scores developed from Mayo Clinic, the Thrombolysis in Myocardial Infarction (TIMI) group and the Grace registry are easily applied. The most widely utilized of these is the TIMI risk score *[R]*.

28. **High Risk**

    High-risk unstable angina patients require a high level of care with close monitoring and intravenous access therapy, including heparin, beta-blockade, and nitroglycerin. This needs to be started in the emergency room setting. Hospitalization usually requires an intensive care unit setting or competent nursing in a monitored bed setting.

29. **Early Therapy**

    See Annotation #25, "Early Therapy", above.

31. **Perform Catheterization Within 24 to 48 Hours**

An early invasive strategy is beneficial in many patients with non-ST-segment elevation myocardial infarction and acute coronary syndrome, especially when coupled with aggressive adjunctive therapy such as unfractionated heparin with a GP IIb/IIIa antagonist or use of an enoxaparin. Certainly the aggressive anticoagulation and antiplatelet agents should be utilized when there are recurrent symptoms and no ability to proceed to early angiography, such as a weather-related delay or the catheterization lab is not available. However, in patients who become unstable or have recurrent symptoms, one should minimize the delay for angiography and percutaneous coronary revascularization.

Contraindications to IIb/IIIa inhibitors include bleeding less than six weeks, intracranial hemorrhage (ever), stroke less than two years, uncontrolled hypertension greater than 200/100 mm Hg, surgery less than six weeks, aortic dissection, acute pericarditis, platelets less than 100,000 mm^3 and dialysis dependent renal failure.

[A], *[C]*, *[M]*, *[R]*

32. **Intermediate Risk**

A patient of intermediate risk unstable angina (as defined by the AHCPR criteria) is by far the most common presentation to the emergency department. Approximately 50% of these patients will turn out to have an end point diagnosis other than acute coronary syndrome. It is, however, impossible to predict which patients truly have an acute coronary syndrome after the initial evaluation in the emergency department. As the short-term risk of a significant cardiac event is between 5% and 20%, it is imperative to treat each patient according to protocol during the evaluation process. The work group recommends a standardized approach or critical pathway approach to these patients that strives to fully diagnose and risk stratify. These patients should be observed in the emergency department for at least six hours or admitted to a chest pain unit or observation unit where serial troponin biomarkers and electrocardiographic assessment can be obtained. It is crucial to perform serial clinical reassessments during the observation period to determine if the symptoms have worsened or the initial baseline risk category assessment remains accurate. Nearly all of these patients should undergo cardiac imaging and stress testing assessment, and many may require outpatient referral to a cardiologist for subsequent evaluation and management. It may be appropriate to consider diagnostic catheterization in certain subgroups of these patients *[R]*.

33. **Early Therapy**

See Annotation #25,"Early Therapy" above.

34. **Admit to Chest Pain Unit or Monitored Bed**

If the patient's risk assessment is not clearly in a high- or low-risk category using AHCPR criteria, and the institution has an emergency room-based chest pain observation unit, admission to this unit would be appropriate. Otherwise, management using a critical pathway for unstable angina with a similar protocol on a monitored bed unit is recommended.

A chest pain unit critical pathway provides monitoring capabilities, a dedicated nurse, serial cardiac markers (markers should be negative for at least six hours from the onset of symptoms), and a post-observation stress test prior to final triage decision. Generally, after successful completion of the evaluation, patients can be classified as low-risk and safely followed up as outpatients in the next few days. In the case of a positive or indeterminate lab test, electrocardiogram or stress/imaging test, or if there is recurrent chest pain during the observation period, a patient should be considered high risk and managed accordingly.

It should be emphasized that a patient who requires repeated doses of nitroglycerin and/or intravenous nitroglycerin or paste, or requires beta-blockade for pain control should be considered high risk *[R]*.

Refer to Annotation #27, "Risk Assessment" above for more information on risk stratification.

35. **Patient Has Positive: Markers? Electrocardiogram Changes? Treadmill Stress Test? Unstable Dysrhythmias?**

    If a patient develops recurrent chest discomfort during the observation period, the patient should be considered having failed the observation unit intervention and should be considered high risk and admitted to a monitored bed or an intensive care unit setting. If the serial cardiac markers, troponin T or I and creatinine kinase-MB on the second blood draw are positive, or the patient develops new or dynamic ST-T wave changes, the patient should also be considered high risk. If a patient develops an unstable dysrhythmia (i.e., ventricular tachycardia or multifocal premature ventricular complexes, etc.), he/she should also be considered high risk and admitted.

    Most patients in this category will have an uneventful observation period and should undergo an endpoint stress test. The choice of a treadmill exercise test utilizing the Bruce treadmill score should be preferred in all patients who can walk and have an interpretable electrocardiogram. In some instances additional imaging may be beneficial. If the patient is unable to walk, a pharmacologic stress test should be considered. Patients needing continued beta-blockade may be candidates for nuclear imaging instead of standard treadmill stress testing *[A], [C]*.

36. **Low Risk**

    Patients with a history of brief episodes of chest pain (less than 20 minutes) but suggestive of accelerating and/or class three or four angina should be considered low risk if indeed an electrocardiogram can be obtained during the chest pain episodes. If, however, an electrocardiogram cannot be obtained during a chest pain episode or other atypical features are present, the patient

may be managed as intermediate risk and be evaluated in a cardiac observation unit.

37. **Discharge to Outpatient Management**

    If the diagnosis is low-risk unstable angina, a follow-up appointment, preferably with a cardiologist, should be done. Otherwise, a follow-up with a primary care physician may also be appropriate. These appointments should occur within one to three days. If the chest pain is considered stable angina and non-anginal chest pain, an arrangement for follow-up with a primary care physician should be arranged in the near future. The primary care physician may want to follow the clinical evaluation algorithm provided within the original guideline document.

38. **Non-Cardiovascular Chest Pain**

    In elevating a patient with chest pain, it is important to keep in mind the entire differential diagnosis, including non-cardiac causes. Missed or misdiagnosis may have serious implications, both in regards to medico-legal issues and resource utilization.

39. **Chest Pain Not Related to Coronary Artery Disease, but Indicative of Other Serious Diagnosis?**

    Aortic dissection, pulmonary embolus, expanding pneumothorax, pericarditis with impending tamponade, or serious gastrointestinal pathology are all potentially life threatening and may closely mimic presentations of an acute coronary syndrome. Further, the presence or absence of reproducible chest wall pain does not preclude the possibility of a more serious underlying cause.

ST-Elevation Myocardial Infarction (STEMI) Algorithm Annotations

42. **ST-Segment Elevation on Electrocardiogram**

    About 40% of patients with acute myocardial infarction present with ST-segment elevation. They can be treated with thrombolytics or with emergency coronary angiography and percutaneous coronary intervention. Patients presenting with chest pain but no ST-segment elevation may be triaged to the telemetry unit if they are hemodynamically stable and pain-free.

    Facilities without percutaneous coronary intervention capabilities should consider establishing processes and criteria for transfer for immediate percutaneous coronary intervention.

43. **Thrombolytics or Percutaneous Coronary Intervention for Initial Therapy**

    Indications for Thrombolytics

    - ST-segment elevation of 1 mm or more in two or more contiguous limb leads **or**

        - ST-segment elevation of 2 mm or more in precordial leads **or**
        - New or presumably new left bundle branch block; ST-segment depression of 2 mm or more in V_1V_2 (true posterior infarction), **and**
    - Anginal chest pain between 30 minutes and 12 hours in duration that is unrelieved with nitroglycerin

When immediately available, percutaneous coronary angioplasty vascularization is equal to and may be superior to thrombolysis *[A]*, *[M]*.

Assessment of Reperfusion Options for Patients with ST-Elevation Myocardial Infarction

Options include full dose lytic of choice (tenecteplase [TNK], reteplase [rPA]), (transfer arrangements with the receiving institution should be worked out in advance; this is a IIb indication per the 2007 American College of Cardiology/American Heart Association [ACC/AHA] guidelines), or transfer for primary percutaneous coronary intervention to a hospital equipped with a catheterization laboratory. Some centers and hospital systems utilize a systems approach for triage and initiation of reperfusion therapy for patients with ST-elevated myocardial infarction. The reperfusion therapy method utilized is based upon time from symptom onset to emergency room arrival and time from spoke to hub hospital catheterization laboratory. Such approaches may combine the use of intravenous lytic therapy, use of a GP IIb/IIIa inhibitor and other adjunctive medications, along with primary percutaneous coronary intervention. The aims of such systems approaches should be to most rapidly initiate and deliver acute reperfusion therapy and establish full coronary patency. There are also hospital systems that utilize pre-hospital electrocardiogram acquisition and notification of an acute coronary reperfusion team for patients with suspected ST-elevated myocardial infarction. Typically these approaches bypass the emergency department and take the patient directly to a catheterization laboratory. Again, the goals of such an approach should be to most rapidly initiate and deliver acute reperfusion therapy and establish full coronary patency.

Low patient weight has been identified as an ongoing risk factor for significant intracranial hemorrhage (ICH) when thrombolytics are administered. It is imperative to accurately estimate the weight of patients with acute myocardial infarction to determine the proper dose of thrombolytic to minimize the risk of intracranial hemorrhage.

Single-bolus agents, such as tenecteplase simplify administration; however patient weight remains important in calculating dose.

Refer to the original guideline document for additional information on lytic administration.

Contraindications to Thrombolytics

Refer to the "Contraindications" field for more information.

Refer to the original guideline document for common causes of delay in initiation of thrombolytics.

45. **Emergency Coronary Angiography and Primary Percutaneous Coronary Intervention**

Key Points:

- Primary percutaneous coronary intervention has been demonstrated to be more effective than thrombolysis in opening acutely occluded arteries in settings where it can be rapidly employed by experienced interventional cardiologists.

Time to open artery is critical to effective primary percutaneous coronary intervention. Current ACC/AHA guidelines suggest that institutions wishing to apply primary percutaneous coronary intervention for ST-segment elevation myocardial infarction should achieve a median door-to-balloon time of 90 minutes or less. The ACC/AHA Consensus Panels have set a 60-minute median door-to-balloon time as the benchmark for top performing institutions *[R]*.

Institutions that cannot meet the recommended treatment times should consider preferential use of intravenous thrombolytic therapy. *These institutions should have a predetermined plan for treating patients who present with contraindication to thrombolytics*.

Aspirin, heparin, nitrates, and beta-blockers should be administered early to these patients, unless contraindicated.

Primary percutaneous coronary intervention may also play a role in the treatment of non-ST-segment elevation myocardial infarction/refractory angina pectoris if angina symptoms fail to resolve within an hour of instituting aggressive anti-anginal therapy with aspirin, heparin, beta-blockers, and GP IIb/IIIa inhibitors; or serial electrocardiogram or echocardiogram suggest a large amount of myocardium at risk.

For centers that have demonstrated high success rates and low complications rates, this strategy is at least equal in efficacy to that of initial thrombolytic therapy, especially for those patients at high risk of mortality, and may be considered in thrombolytic candidates, as well as in patients with thrombolytic contraindications. It is the preferred therapy for cardiogenic shock. Immediate transfer of salvageable patients to an institution capable of treating this condition is indicated for the presentation or development of cardiogenic shock *[C]*.

Rescue angioplasty involves the use of percutaneous coronary intervention to restore coronary flow after thrombolysis has failed. Guidelines for time from arrival to balloon inflation are not established for this complex subset of patients, but rescue percutaneous coronary intervention should be accomplished within 90 to 120 minutes of thrombolytic failure if possible. Thrombolytic failure may be evident by failure of ST-elevation to resolve

within 30 to 60 minutes of thrombolytic therapy and usually includes persistent symptoms.

Facilitated percutaneous coronary intervention is the use of additional agents to pretreat the patient awaiting primary percutaneous coronary intervention. No strategy employing full- or reduced-dose thrombolytic (with or without a GP IIb/IIIa receptor inhibitor) has been approved for facilitated percutaneous coronary intervention. GPIIb/IIIa inhibitors should be considered in patients with symptoms refractory (persistent chest pain or electrocardiogram changes consistent with ischemia) to standard therapy. Otherwise these agents may be given at the time of angiography. Based on REPLACE-2 study, a reasonable alternative to heparin is to use bivalirudin for patients who will be undergoing percutaneous coronary interventions.

Current ACC/AHA guidelines recommend treating the culprit vessel when feasible and deferring surgical or percutaneous coronary intervention -based revascularization of other vessels until the patient has stabilized and the clinically most appropriate strategy determined.

[A]

48. **Critical Care Unit Admission**

Patients who present with acute ST-segment elevation, hemodynamic instability, or both should be admitted to the critical care unit. Early use of adjunctive medications can be reconsidered. Once the issue of surgery is clarified, consider the early use of clopidogrel for those in whom percutaneous coronary intervention is planned. (See Emergency Interventions Algorithm Annotations #20 to #31.) A critical care unit admission order set template has been developed by the ICSI acute coronary syndrome work group and is available from ICSI -- see the related ICSI Scientific Documentation section of the original guideline document.

49. **Critical Care Unit Care: Chronic Adjunctive Medications/Phase One Cardiac Rehabilitation**

A protocol should be in place to guide routine orders for continuous monitoring, oxygen delivery, intravenous access therapy, activity, laboratory and diagnostic tests, diet, and medications.

Use of the following medications should be considered:

- **Aspirin*** - should be continued as the clinical situation warrants. Aspirin has been shown to reduce reinfarction and mortality long-term, and should be continued whenever possible. Use of non-steroidal anti-inflammatory drugs and COX-2 inhibitors may reduce the cardioprotective benefits of aspirin *[R]*.
- **Clopidogrel**** - Aspirin (dose should be 81 mg when given with clopidogrel) with clopidogrel in intermediate and high-risk acute coronary syndrome patients is beneficial. Anyone with an allergy to aspirin or non-steroidal anti-inflammatory drugs should receive a bolus

dose of clopidogrel (300 mg) with maintenance dosing indefinitely. For patients who present with unstable angina, non-ST elevation myocardial infarction or ST-elevation myocardial infarction without revascularization who are not at high risk for bleeding, clopidogrel should be continued for at least one year. For patients undergoing a bare metal stent, clopidogrel should be continued for at least one month. For patients who receive a sirolimus eluting stent, clopidogrel should be continued for at least 12 months regardless of stent type. Aspirin plus clopidogrel or clopidogrel alone can also be used with patients who have stents. If clopidogrel is given and coronary artery bypass surgery planned, clopidogrel should be held for five days prior to surgery due to increased risk of perioperative bleeding.

- **Beta-Blockers*** - Beta-blockers reduce mortality, readmission, and reinfarction for both coronary artery disease and congestive heart failure. They should be instituted and/or continued whenever possible. Intravenous esmolol should be considered if a clinician is concerned about potential adverse effects of beta-blockers. Patients who prove intolerant of a beta-blocker after a large infarction should be reconsidered for beta-blocker therapy after discharge *[A]*.
- **ACE inhibitors*** - ACE inhibitors are indicated (angiotensin receptor blockers if ACE inhibitors aren't tolerated in addition to beta-blockers, when possible) for most patients following acute myocardial infarction to reduce mortality and morbidity associated with large infarcts with significant left ventricular dysfunction, to reduce adverse ventricular remodeling that may result in further reduction in ejection fraction, and for potential reduction of future myocardial infarction and stroke. Consider hydralazine/isosorbide dinitrate if intolerant to ACE inhibitors or angiotensin receptor blockers or either drug is contraindicated.

*Shown in large clinical trials to reduce infarction mortality in all myocardial infarctions.

**Shown in large clinical trials to reduce infarction mortality in non-ST-elevation myocardial infarctions

- **Calcium channel blockers** may be useful for control of blood pressure and ischemic pain when beta-blockers are contraindicated but should be avoided in patients with decreased left ventricular function or heart failure. The short-acting dihydropyridine calcium channel blockers (e.g., nifedipine) may be associated with increased risk and should be avoided in acute ischemic syndromes.
- **Oral nitrates** may benefit selected patients with postinfarction angina or congestive heart failure.
- **Low-molecular-weight heparin** (enoxaparin) has been shown to be superior to unfractionated heparin in patients without ST-segment elevation and can preferentially be used in subcutaneous dosing (e.g., enoxaparin sodium 1 mg/kg every 12 hours). Heparin may be continued for two to four days or maintained until conversion to warfarin is completed. If unfractionated heparin is used, the dose should be regulated to maintain an activated partial thromboplastin time of 50 to 75 seconds.

- **Warfarin** therapy may be initiated in certain clinical situations (e.g., postinfarction congestive heart failure or anterior myocardial infarction with high risk of left ventricular thrombus) as soon as clinical stability is achieved and invasive diagnostic studies are completed. The usual target international normalized ratio is 2.0 to 3.0.
- **Oral antiarrhythmics** are not recommended, especially when left ventricular function is reduced. Flecainide acetate and sotalol hydrochloride should be avoided in patients with significant structural heart disease unless clearly indicated on the basis of electrophysiologic study for the suppression of life-threatening ventricular arrhythmias. Beta-blockers are the current drug of choice when tolerated. Routine use of amiodarone hydrochloride in post-myocardial infarction patients with non-sustained ventricular ectopy has not been shown to reduce mortality.
- **Statins**. The large majority of patients who have an acute myocardial infarction have high serum lipid levels. Lipid treatment, including administration of statins, should be addressed as soon as possible. A patient's lipid status should be determined within the first 24 hours. If the low-density lipoprotein level is greater than 70 mg/dL, the patient should be started on a statin within the first 24 hours of the onset of myocardial infarction *[A]*.
- **Tobacco cessation** should be addressed as soon as possible for patients who smoke or use tobacco products.
- **Glycemic control**. Tight control of blood glucose in patients with diabetes is recommended. Patients with diabetes mellitus have greater short-term and long-term mortality after acute myocardial infarction than patients without diabetes *[B]*. Diabetes is also an independent predictor of mortality following other acute coronary syndromes *[B]*. Even in patients without a previous diagnosis of diabetes, hyperglycemia on admission for an acute myocardial infarction is associated with higher mortality than those without elevations of glucose. Recent studies *[A]* have important limitations in terms of the efficacy of glycemic control in patients with an acute myocardial infarction. Whether control of glycemia is sufficient to reduce morbidity and mortality is not proven at this time. Given the lack of convincing evidence, the glucose targets during an acute myocardial infarction are not clearly defined. The 2004 ACC/AHA guidelines for ST-elevation myocardial infarction recommend an insulin infusion to "normalize" blood glucose in patients with both uncomplicated or complicated courses. The 2007 ACC/AHA guidelines on non-ST-elevation myocardial infarction are more specific, recommending a target of pre-prandial glucose of less than 110 mg/dl (6.1 mmol/L) with a maximum glucose of less than 180 mg/dl (10 mmol/L) in all patients with diabetes. This is in keeping with targets proposed by the American Diabetes Association and the American College of Endocrinology. Neither of these guidelines specifically addresses the important issue of new hyperglycemia in a patient without a prior history of diabetes. Because these individuals appear to be at even greater risk than those with diabetes, equally aggressive glucose targets seem logical.

Phase One Cardiac Rehabilitation

With shortened length of stay, teachable moments may be limited. As a result, timely initiation of education on lifestyle modification is crucial. Phase one cardiac rehabilitation should begin as soon as the patient is stable and pain-free. Goals are to minimize harmful effects of immobilization, assess the hemodynamic response to exercise, manage the psychosocial issues of cardiac disease, and educate the patient and family about lifestyle modification including:

- Tobacco cessation
- Dietary instruction including a heart healthy diet
- Manageable exercise regimen

50. **Complications?**

Arrhythmic complications include sinus bradycardia, Möbitz I block (Wenckebach), Möbitz II block, complete heart block or asystole, premature ventricular contractions, ventricular tachycardia, ventricular fibrillation, accelerated idioventricular rhythm, and supraventricular arrhythmias (atrial flutter, atrial fibrillation, and supraventricular tachycardia). Ischemic complications include postinfarction angina. Mechanical complications include papillary muscle dysfunction, rupture with significant mitral regurgitation, ventricular septal rupture, myocardial rupture, right ventricular infarction, pericarditis with or without tamponade, left ventricular dysfunction, and aneurysm formation *[C]*, *[M]*.

52. **Transfer to Post-Critical Care Unit Care**

Patients should be transferred from the critical care unit to the telemetry or step-down unit when they are pain-free, hemodynamically stable, and meet the institution's protocol for admission to the telemetry unit (usually 12 to 24 hours after myocardial infarction). Discontinuation of cardiac monitoring should be considered for patients who attain electrical stability (usually within three days of infarction).

54. **Risk Stratification**

Assessment of ejection fraction is important in predicting prognosis. Most patients should undergo echocardiography or other assessment of left ventricular ejection fraction. A treadmill test is useful for assessing functional reserve but is not useful for predicting recurrence of acute myocardial infarction. If ST-segment depression or angina is present early in treatment, angiography should be considered. If the patient is unable to exercise, pharmacologic stress testing should be considered, and if the electrocardiogram is uninterpretable, stress imaging (nuclear or echocardiographic) should be considered.

Patient with no high-risk indications following thrombolytics therapy may be stratified non-invasively into low, medium, and high risk.

Some clinicians may elect to measure multiple cardiac biomarkers in patients with myocardial infarction. This may especially be helpful in those in whom

risk stratification is not available by other clinical evidence. The work by Sabatine, Morrow et al demonstrated the utility of cardiac troponins, C-reactive protein and B-type natriuretic peptide measurements. This work demonstrated that patients with elevations of all three cardiac biomarkers had significantly higher risks of recurrent myocardial infarction and death than those with only two or one elevated. There was a progressive step-wise increase in risk going from one abnormality to two abnormalities to elevations of all three biomarkers. For patients with obvious clinical heart failure there is little utility in measuring B-type natriuretic peptide during hospitalization for acute myocardial infarction. At present, there is no clear consensus about what to do with an elevated B-type natriuretic peptide measurements value during hospitalization for acute myocardial infarction. Some have suggested there is limited utility in measuring B-type natriuretic peptide in patients if one is planning an intentional invasive strategy as well. Some have suggested that a lack of B-type natriuretic peptide elevation may identify patients hospitalized for acute myocardial infarction who are eligible for early discharge strategies. Further studies are warranted to fully understand how to apply B-type natriuretic peptide values in these populations. The most prudent strategy may be to not measure B-type natriuretic peptide in the great majority of patients until further data are available *[B]*, *[R]*.

55. **Patient at Increased Risk and Needs Intervention?**

Patients who are at increased risk for adverse prognosis after acute myocardial infarction and who are also candidates for short-term intervention include those with a large amount of myocardial necrosis (ejection fraction less than 40%), residual ischemia (angina during hospitalization or exercise testing), electrical instability (greater than 10 PVC/hr), left main or three-vessel coronary artery disease, limited exercise tolerance, or rales/crackles in more than one-third of lung fields.

The following factors increase long-term risk:

- 70 years of age or older
- Previous infarction
- Anterior-wall myocardial infarction
- Hypotension and sinus tachycardia
- Diabetes
- Female gender
- Continued smoking
- Atrial fibrillation
- Heart failure

Patients able to exercise more than four metabolic equivalents (METs) had less than a 2% subsequent incidence of death or myocardial infarction within one year compared with 18% for those in the high-risk group *[B]*.

56. **Cardiac Catheterization**

Angiography should be performed in patients at increased risk as defined in Emergency Intervention Algorithm Annotation #27, "Risk Assessment."

Recent trials (collectively FRISC II and TACTICS-TIMI 18) suggest an early aggressive/invasive approach (early diagnostic coronary angiography and appropriate percutaneous coronary intervention or coronary artery bypass graft) within 48 hours of presentation, in non-ST acute coronary syndrome (with ST-segment deviation, elevated cardiac markers or TIMI Risk Score greater than 3), significantly reduces the risk of major cardiac events. However, the majority of non-ST-elevation myocardial infarction patients should undergo coronary angiography *[A]*.

57. **Revascularization Candidate?**

Coronary artery bypass graft should be considered in patients with left main, three-vessel or two-vessel disease with left anterior descending coronary artery involvement and demonstration of ischemia or in patients who would not receive the ideal benefit from percutaneous coronary intervention. Pharmacologic or stress test imaging may be helpful if myocardial viability is uncertain and revascularization is considered.

Percutaneous coronary intervention should be considered for patients with acceptable anatomy in whom its prognostic effect has been most clearly demonstrated: significant residual ischemia, coronary artery bypass graft candidacy, and failure of maximal medical therapy (two of three medications) to control angina or contraindications to medications.

60. **Continue Adjunctive Medications**

See STEMI Algorithm Annotation #49, "Critical Care Unit Care: Chronic Adjunctive Medications/Phase One Cardiac Rehabilitation" above.

61. **Secondary Prevention and Risk Factor Modification**

Modification of risk factors (e.g., high lipid levels, hypertension, smoking) significantly reduces subsequent cardiovascular mortality. Risk factor counseling must be documented in the medical record in a consistent manner. A "care plan" or "critical pathway" approach with flow sheets may be used. Ongoing patient monitoring and feedback are important. Adjunctive therapy (aspirin or clopidogrel if aspirin allergic, beta-blockers, warfarin for large anterior infarctions, ACE inhibitors, and statins) should be continued.

Efforts targeted at exercise (as an adjunct, in the management of other risk factors), lipid management, hypertension control, and smoking cessation can reduce cardiovascular mortality, improve functional capacity, attenuate myocardial ischemia, retard the progression and foster the reversal of coronary atherosclerosis, and reduce the risk of further coronary events *[A]*.

The Cooperative Cardiovascular Project has documented a discrepancy between risk factor counseling documentation and actual practice during hospital stays of patients with myocardial infarction. Therefore, documentation of smoking cessation counseling has become one of 13 indicators judged to be representative of quality care by the Cooperative Cardiovascular Project steering committee *[D]*.

1. Smoking cessation is clearly linked to mortality and morbidity after myocardial infarction.
2. Aggressive treatment of dyslipidemia can reduce subsequent myocardial ischemia.
3. Hypertension control will reduce recurrent cardiac events.
4. Exercise alone is only modestly effective for secondary prevention.
5. A case management system may be more effective than usual care in long-lasting risk factor modification.
6. Initiate depression screening and medical management when appropriate.

Teaching must be done when the patient is ready, and ideally is based on patient-derived learning priorities. Teaching moments may be best taken advantage of by a team approach involving physician and nursing staff during the hospital stay. Ongoing outpatient follow-up and progress feedback are important for patient adherence *[M]*, *[R]*.

Depression affects one in four acute myocardial infarction patients and delay in treatment of depression is associated with poorer outcomes *[A]*. The SADHART trial *[A]* suggested a benefit from the early diagnosis and treatment of depression in acute myocardial infarction patients. Depression associated with myocardial infarction is underdiagnosed and referral for treatment initiation is inefficient. The Primary Health Questionnaire 9 (PHQ-9) is a validated tool for the rapid diagnosis of moderate and severe depression. A score of 15 or higher indicates moderate depression and a score of 20 or higher indicates severe depression. Refer to the NGC summary of the ICSI guideline Major Depression in Adults in Primary Care for additional information.

62. **Discharge**

Complete and document the following before discharge:

- Patient education that includes discharge diagnosis, medical regimen, lifestyle modification issues, and functional limitation (including resumption of sexual activity and driving)
- Scheduling of a follow-up appointment with the primary care physician
- Targeting a return-to-work date. Patients with sedentary jobs often return to work in two to three weeks. More physically demanding jobs often can be resumed in four to six weeks unless significant ischemia is present.

Patients are commonly discharged in less than three days following successful primary percutaneous coronary intervention with evidence of complete or near complete salvage of threatened myocardium. Though patients should avoid strenuous exertion for several weeks during the stent healing phase, many such patients may return to sedentary or only moderately active work activities within days of discharge.

Most patients with uncomplicated myocardial infarctions should be discharged within five days. Patients undergoing primary percutaneous coronary intervention who are at low risk with an uncomplicated course may be

discharged on the third day. Early reperfusion and definitive angiography revealing little or no residual injury or disease has increasingly demonstrated improved myocardial salvage and enhanced patient stability. Discharge may be individualized according to the degree of salvage and stability. In many centers some patients are safely discharged within 24 hours when salvage is nearly complete *[A]*.

Information on discharge medication is attached in Appendix A, "Medications to Consider on Discharge" in the original guideline document.

63. **Phase Two Cardiac Rehabilitation --If Available**

Outpatient Cardiac Rehabilitation/Secondary Prevention programs are recommended for patients diagnosed with ST-elevation or non-ST-elevation myocardial infarction. Of particular concern are those patients who carry a moderate or high risk or have multiple modifiable risk factors for coronary artery disease and for whom supervised exercise training is deemed appropriate.

There are exceptions to this recommendation, which include patient-oriented barriers, provider-oriented criteria (such as a patient who is deemed to have a high-risk condition or contraindication to exercise), or health care system barriers (such as patient who resides a significant distance from a program) *[R]*.

Home exercise training programs have been shown to be beneficial in certain low-risk patient groups but lack the valuable elements of education and group interaction *[A]*, *[R]*.

Certain patients felt to be at higher risk of complications postdischarge are more likely to require monitoring during exercise in the immediate postdischarge period *[M]*, *[R]*

The U.S. Public Health Service described Phase Two cardiac rehabilitation as a "comprehensive, long-term program including medical evaluation, prescribed exercise, cardiac risk factor modification, education and counseling. Phase Two refers to outpatient, medically supervised programs that are typically initiated one to three weeks after hospital discharge and provide appropriate electrocardiographic monitoring."

Research shows that a cardiac rehabilitation program based on regular exercise and education focused on risk factor reduction is both efficient and effective in altering the course of coronary heart disease *[R]*. For certain patients, referral to a Phase Two program may facilitate earlier hospital discharge by providing emotional support in the outpatient hospital setting.

Services delivered by a cardiac rehabilitation program may be considered "reasonable and necessary" for up to 36 sessions, and patients typically participate two to three times per week for 12 to 18 weeks *[R]*.

Cardiac rehabilitation programs have been shown to decrease mortality but have no effect on nonfatal recurrent myocardial infarctions *[M]*. Unless there is a long-term effort of encouragement, most patients will revert back to previous sedentary activities *[A]*.

Program Requirements

A cardiac rehabilitation program should include evaluation and assessment of modifiable cardiovascular risk factors, development of individualized interventions, and communication with other health care providers. Submeasures should include the following individualized assessments:

1. Tobacco use
2. Blood pressure control
3. Lipid control
4. Physical activity habits
5. Weight management
6. Diabetes management
7. Presence or absence of depression
8. Exercise capacity
9. Adherence to preventive medications

[R]

Additional Goals of Phase Two Rehabilitation

- Increase exercise tolerance and endurance to enable patient to perform activities of daily living, at a level that resumes or exceeds their previous level of function
- Improve quality of life
- Improve psychological well-being and provide emotional support
- Provide educational support and resources

Education Topics

- Anatomy and physiology of the heart
- Nutrition
- Heart disease risk factors and modification
- Stress reduction
- Emotional aspects of heart disease
- Cardiac medications
- Aerobic exercise and exercise progression
- Cardiac signs and symptoms

Exercise Prescription

An exercise prescription will be developed, taking into consideration the following factors:

- Patient's past medical history

- Recent cardiac or pulmonary event with symptomatology, interventions, estimated ejection fraction, complications in recovery process
- Risk factor identification
- Current medications, oxygen use
- Past exercise history
- Exercise history since cardiac event
- Orthopedic impairments
- Barriers to learning
- Vocational and leisure time activities

An exercise prescription consists of:

Mode – The emphasis is aerobic exercise – continuous activity for 30 to 40 minutes, using large muscle groups. Options include treadmill, stationary bike, recumbent bike, airdyne bike, Nustep, elliptical machine, upper body ergometer, hallwalking and chair aerobics. Pure isometric exercise should be minimized because it may result in LC decompensation in patients with poor left ventricular function.

Frequency – Two to three times per week supervised in rehab and additional home exercise program daily.

Duration – A goal of 30 to 40 minutes total including five-minute warm-up and five-minute cool-down.

Intensity – Initial exercise intensity will be based on diagnosis and previous exercise history. If patient is just beginning an exercise program, initial training will usually range from two-three METs (i.e., two-three miles per hour, 0% grade on treadmill, or 25 to 50 watts on bicycle). In patients with an angina threshold of two-three METs, exercise training may not be appropriate.

Progression – A gradual increase of 0.5-1.0 METs will be prescribed as tolerated with a MET goal established individually at initial evaluation session.

Exercise Tolerance and Assessment Tools

Exercise tolerance will be assessed by monitoring heart rate response, blood pressure response and Borg Rating of Perceived Exertion, with desired level being 11 to 13.

Exercise heart rate – Taking into consideration the above information, an exercise heart rate guideline will be calculated. This applies to patients who are not taking a beta-blocker and who have been shown to tolerate the exercise heart rate without ischemia.

- Age-adjusted maximum heart rate multiplied by 60%-75%
- Age-adjusted multiplied by 60%-80% if approved by physician
- 20 to 30 above resting heart rate
- Graded stress test

Monitoring rate of perceived exertion is very useful. This is advantageous for many reasons: it is unaffected by negative chronotropic medications, unlike heart rate monitoring; it is quite reproducible across age, gender and cultural origin; and lastly, it only requires patient attunement to symptoms *[R]*.

Monitoring METs – Monitoring is determined by the patient's post-myocardial infarction exercise tolerance test and/or in rehabilitation and is highly individual.

64. **Chronic Adjunctive Medications/Outpatient Management**

Use of enteric-coated aspirin or aspirin plus clopidogrel should be continued. Use of beta-blockers following myocardial infarction has been shown to reduce ischemia, prevent arrhythmias and reinfarction, and improve survival. Patients with large anterior infarctions may benefit from therapeutic warfarin therapy (international normalized ratio 2-3), usually for 3 months to reduce risk of systemic emboli. ACE inhibitors provide long-term cardiac protection for patients (with or without symptoms) with left ventricular ejection fraction of less than 40%.

Most patients should be receiving a statin or alternative lipid-lowering medication at discharge from the hospital. Lipid-lowering therapy should be considered for patients who have undergone percutaneous coronary intervention or coronary artery bypass graft and patients whose low-density lipoprotein cholesterol level is 100 mg/dL or greater. Calcium channel blockers should be considered only for patients with non-ST-elevation myocardial infarction who cannot take beta-blockers and patients without congestive heart failure or decreased left ventricular ejection fraction. Oral nitrates should be considered for patients with ongoing ischemia *[R]*.

Clinicians should be measuring low-density lipoprotein cholesterol and C-reactive protein levels in patients following myocardial infarction. Recent evidence has revealed that use of statin therapy following hospitalization for acute myocardial infarction reduces long-term risks. A sub-study from the PROVE-IT trial has demonstrated that the achievement of low-density lipoprotein less than 70 and C-reactive protein less than 2 mg/l around 30 days following hospitalization was associated with the lowest risk of recurrent clinical events by two years of follow-up. The achievement of these goals was more important than the selection of an individual statin agent. This evidence supports the measurement of low-density lipoprotein cholesterol and C-reactive protein levels about one month following hospital discharge and the aggressive use of statin therapy to achieve low-density lipoprotein less than 70 mg/dl and a C-reactive protein of less than 2 mg/l by that time frame. Some patients may achieve these values through moderate statin doses, most will require higher doses of potent statins, and some patients will require combination therapy with a statin plus ezetimibe. Of interest, achievement of either goal alone (low-density lipoprotein less than 70 or C-reactive protein less than two) but not both was associated with significantly higher recurrence risks *[A]*.

65. **Phase Three/Phase Four Cardiac Rehabilitation If Appropriate**

Phase Three Cardiac Rehabilitation

Phase three is a maintenance program based on the continuation of a heart healthy lifestyle. The program is designed for patients who have completed a Phase Two cardiac rehabilitation program or for individuals with a cardiac history or significant cardiac risk factors. Patients are not continually monitored by electrocardiogram, but spot check electrocardiograms and daily blood pressures and heart rates are recorded. Trained staff, when available, continues to provide support and education for risk factor modification and exercise progression. Warm up, aerobic exercise, stretching, and strength training (when appropriate) are included in Phase Three.

Phase Four Cardiac Rehabilitation

Phase Four cardiac rehabilitation begins after the desired functional capacity has been attained (usually greater than or equal to eight METs) and/or VO_2max has reached a plateau. Maintenance is the principal goal. The exercise prescription should continue as at the end of Phase Three unless angina or exercise intolerance develops, either of which requires cessation of exercise and urgent medical attention.

Acute Myocardial Infarction Complications Algorithm Annotations

68. **Arrhythmic Complication(s)?**

Arrhythmic complications including sinus bradycardia, Möbitz I (Wenkebach), premature ventricular complexes, accelerated idioventricular rhythm, and supraventricular arrhythmias (transient atrial flutter, atrial fibrillation, supraventricular tachycardia, and hemodynamic instability) are generally benign and will usually require symptomatic therapy. Transient Mobitz II block with myocardial infarction may be treated symptomatically. Permanent pacing is indicated for persistent and symptomatic second and third degree atrioventricular block *[D]*.

Six Centers for Medicare and Medicaid Services (CMS) covered indications for defibrillators:

1. Documented episode of cardiac arrest due to ventricular fibrillation (VF), not due to transient or reversible cause
2. Documented sustained ventricular tachyarrhythmia, either spontaneous or induced by an electrophysiology study, not associated with an acute myocardial infarction and not due to transient or reversible cause
3. Documented familial or inherited conditions with a high risk of life threatening ventricular tachyarrhythmia, such as long QT syndrome or hypertrophic cardiomyopathy
4. Coronary artery disease with documented prior myocardial infarction, ejection fraction less than 35%, an inducible sustained ventricular tachyarrhythmia , or ventricular fibrillation at electrophysiology study
5. Documented prior myocardial infarction, ejection fraction less than or equal to 30%, QRS duration of greater than 120 msec (patient must not have Class IV heart failure, shock, coronary artery bypass graft,

percutaneous coronary intervention, myocardial infarction within three months or a need for coronary revascularization or predicted survival less than one year)

6. Patients with dilated cardiomyopathy, documented prior myocardial infarction, heart failure, and left ventricular ejection fraction less than or equal to 35% for longer than nine months

69. **Treat Arrhythmic Complication(s)**

Key Points:

- Advanced cardiac life-support guidelines provide in-depth descriptions of short-term treatment.

Refer to the original guideline document for more information on treatment of arrhythmic complications, including atrioventricular/bundle branch blocks, ventricular arrhythmias, accelerated idioventricular rhythm, and supraventricular arrhythmias.

70. **Ischemic Complication(s)?**

Ischemic complications include postinfarction angina.

71. **Treat Ischemic Complication(s)**

Treatment of postinfarction angina should be correlated with electrocardiogram changes, if possible. Optimal therapy consists of beta-blockers and long-acting nitrates. If beta-blockers are not tolerated or are ineffective and left ventricular function is not significantly depressed, a calcium channel blocker may be used. Early coronary angiography should be considered. Angina after myocardial infarction may be confused with pericarditis. Aneurysm formation should be a consideration.

72. **Mechanical Complication(s)?**

Mechanical complications may include papillary muscle dysfunction or rupture with significant mitral regurgitation, ventricular septal rupture, myocardial rupture, right ventricular infarction, pericarditis with or without tamponade, left ventricular dysfunction, and aneurysm formation.

73. **Treat Mechanical Complication(s)**

Papillary muscle dysfunction is evidenced by the murmur of mitral regurgitation, typically within five days of infarction.

Papillary muscle rupture may occur within 10 days of the event. Findings include development of sudden congestive heart failure or pulmonary edema, often but not always accompanied by a new holosystolic apical murmur. Diagnosis is verified by echocardiography. Stabilization is achieved by one or more of the following: aggressive use of diuretics and vasodilators, insertion of a Swan-Ganz catheter, insertion of an intra-aortic balloon pump. Because

of the high mortality rate with this complication, urgent surgical repair is indicated.

Ventricular septal rupture occurs within one week of infarction and results in left-to-right shunting and subsequent hemodynamic deterioration. Ventricular septal rupture is suggested by the presence of a new, harsh, holosystolic murmur that is loudest along the lower left sternal border; this may be accompanied by a thrill. Patients may also have symptoms of right-sided heart failure with right ventricular PO_2 step-up and may have less pulmonary congestion than patients with papillary muscle rupture. The diagnosis is confirmed by two-dimensional echocardiography. Patients are best stabilized by vasodilator therapy, insertion of a Swan-Ganz catheter or an intra-aortic balloon pump, or all of these. Because of the high mortality rate, urgent surgical repair is indicated.

Myocardial rupture is a common cause of sudden death after acute myocardial infarction. Symptoms or findings include emesis, persistent restlessness, anxiety, and persistent ST-wave elevation on electrocardiogram. Rupture usually occurs within five to seven days of myocardial infarction. Left ventricular free-wall rupture leads to hemopericardium and subsequent death from tamponade. Contained rupture may result in formation of a pseudoaneurysm. Surgical resection is recommended.

Right ventricular infarction is suspected in patients with inferior infarction complicated by low cardiac output, hypotension, oliguria, jugular venous distention, and clear lung fields without radiographic evidence of pulmonary venous congestion. Infarction can be confirmed by electrocardiogram findings (ST-segment elevation in right precordial leads V_4R through V_6R in the presence of inferior ST-elevation), two-dimensional echocardiography, or pulmonary artery catheter demonstrating a disproportionate elevation of right atrial pressure compared with pulmonary capillary wedge pressure. Treatment consists of intravascular volume expansion and use of inotropic agents; if the patient loses sinus rhythm, temporary pacing to re-establish atrioventricular synchrony should be considered. Agents that reduce right ventricular preload, such as nitroglycerin, diuretics, and large doses of morphine, should be avoided. ACE inhibitors and beta-blockers may require dose reduction or discontinuation with milder presentation of right ventricular dysfunction post-myocardial infarction *[D]*, *[R]*.

Post-myocardial infarction pericarditis can be early (occurring within 72 to 96 hours after acute myocardial infarction) or occasionally delayed (typically occurring weeks after myocardial infarction); the latter is called Dressler's Syndrome. Early pericarditis is suspected in patients with pericardial friction rub, usually heard on the second or third day after acute myocardial infarction, and chest pain that may extend to the back, neck, or shoulders that is intensified by movement and respiration and relieved by sitting up or leaning forward. Treatment consists of anti-inflammatory agents and reassurance. Echocardiography to assess for possible incomplete myocardial rupture should be considered. It is important to emphasize to the patient that the recurrent pain is not the result of recurrent infarction. Risk of hemopericardium is increased in patients receiving anticoagulants;

development of a pericardial effusion can be detected by close clinical observation and echocardiography *[B]*.

Dressler's Syndrome is characterized by an increase in erythrocyte sedimentation rate, leukocytosis, and more frequent pleural and pericardial effusions than in early pericarditis. The Incidence of Dressler's Syndrome is roughly 1% to 3% of acute myocardial infarction patients. Because of the increased incidence of pericardial effusion, anticoagulation should be used with caution. Treatment for pericardial effusion with impending tamponade is pericardiocentesis, preferably guided by echocardiography *[B]*.

Risk of developing left ventricular dysfunction and subsequent heart failure is greatly increased in patients with more extensive myocardial infarction. Restricted diastolic filling patterns on echocardiography may predict subsequent clinical heart failure.

[A]

Refer to the original guideline document for more information.

Special Work-Up Algorithm Annotations

77. **Clinical Features Suggest Dissecting or Symptomatic Aneurysm?**
    - Clinical findings of ischemia involving several organ systems
    - Pain typically "tearing" or "ripping"
    - Pain radiation from chest to back, hips and lower extremities
    - Common findings: hypertension, cardiac murmurs, systolic bruits, diminished or absent pulses
    - Chest x-rays - abnormalities around aortic knob, increased diameter of ascending aorta
    - Blood pressure discrepancy between right and left arm

78. **Diagnosis of Dissection, Immediate Computerized Tomography Angiogram or Echo/Transesophageal Echocardiogram; Magnetic Resonance Imaging if Clinically Stable and Patient Asymptomatic**
    - Computerized tomography angiogram is generally the quickest and most readily available diagnostic test.
    - Trans-esophageal echocardiogram with a biplane probe is equally diagnostic and preferable in patients with renal insufficiency or allergy to contrast dye.
    - Magnetic resonance imaging remains the most accurate test, but requires a stable patient. Magnetic resonance imaging should be avoided if a type A dissection is suspected.

79. **Test Diagnostic of Type A Dissection or Symptomatic Aneurysm?**

    The imaging procedure should establish the presence or absence of an aneurysm and the presence or absence, and location, of a dissection.

80. **Arrange for Immediate Cardiovascular Surgery Consultation/Nitroprusside + Esmolol Drip**

- Surgical intervention for symptomatic thoracic aneurysms and proximal (type A; ascending aorta) dissections *[R]*
- Control blood pressure with nitroprusside or esmolol drips

81. **Treatment of Distal Dissection**
    - Distal (type B; distal to left subclavian artery) aortic dissections generally appropriate for pharmacologic therapy
        - Nitroprusside or esmolol drips to control blood pressure and heart rate (eliminate pain and stabilize dissection)
        - Consider surgery if therapy not effective

82. **Symptoms, Arterial Blood Gases, Chest X-Ray Suggest Pulmonary Embolus?**
    - Symptoms may include dyspnea, tachypnea, pleuritic chest pain
    - Physical findings extremely variable, may include fever, wheezing
    - Electrocardiogram - non-specific ST-T changes
    - Chest x-ray - normal, pleural effusion, wedge-shaped infiltrate
    - Arterial blood gases - abnormal A-a gradient

84. **Symptoms, Arterial Blood Gases, Chest X-Ray Suggest Pneumothorax?**
    - Idiopathic or spontaneous pneumothorax - sudden onset of pleuritic chest pain and dyspnea (pleuritic pain more prominent with small pneumothorax, dyspnea with large)
    - Arterial blood gases may be abnormal

85. **Consider Chest Tube and Hospitalization**
    - Pneumothorax greater than 10% to 20% usually requires chest tube
        - Primary pneumothorax - occurs in otherwise healthy people (idiopathic most frequently in tall young males, catamenial associated with endometriosis and menses) *[R]*
        - Secondary pneumothorax - chronic obstructive pulmonary disease, asthma, pneumonia, cystic fibrosis *[R]*
    - Outpatient treatment possible if progression unlikely and patient reliable
        - Catheter aspiration followed by several hours of observation
        - Indwelling catheter attached to Heimlich valve
    - Inpatient treatment if pneumothorax is secondary or significant symptoms
    - Reabsorption slow - 1.25% per day

86. **Symptoms, Signs Suggest Pericardial Disease?**
    - Chest pain worsened with inspiration, coughing, position changes or swallowing
    - Pericardial friction rub
    - Electrocardiogram - ST-T changes
    - Etiology - infectious, neoplastic, metabolic, inflammatory autoimmune disorders, post-myocardial infarction (Dressler's syndrome)
    - Drug related - hydralazine, procainamide, isoniazid, phenytoin, doxorubicin
    - Consider blunt trauma, post-op

87. **Tamponade?**
    - Chest pressure and shortness of breath
    - Exam - elevated jugular venous pressure, hypotension, tachypnea, narrow pulse pressure, pulsus paradoxus greater than 20 mmHg
    - Electrocardiogram may reveal electrical alternans
    - Chest x-ray- normal or enlarged cardiac silhouette
    - Echocardiogram diagnostic test of choice
    - Pericardial space typically contains 50 cc of fluid, with chronic accumulation may contain up to 2,000 cc
    - With acute, rapid accumulation, overt tamponade may develop with as little as 150 cc *[R]*

88. **Pericardiocentesis - Prefer Echocardiogram-Directed**
    - Echocardiogram-directed apical pericardiocentesis procedure of choice
    - Subxyphoid approach if echocardiogram not available and patient unstable

    [D]

89. **Admit to Critical Care Unit/Monitored Bed**

    The patient should be observed in a critical care unit/monitored bed setting *[R]*.

90. **Echocardiogram; Discharge?/Consider Treatment**
    - Pericarditis without tamponade -- obtain echocardiogram
    - Nonsteroidal anti-inflammatory drugs or aspirin and close follow-up for viral or idiopathic

Non-Cardiac Causes Algorithm Annotations

92. **Symptoms, Signs, Chest X-Ray Suggest Pleural or Parenchymal Pulmonary Disease?**

    Patients with pulmonary or pleural disease frequently have a presenting complaint of chest pain with or without shortness of breath. A detailed history, physical examination, electrocardiogram, chest x-ray, and laboratory evaluation typically will often suggest the diagnosis. Differential diagnoses include chronic obstructive pulmonary disease (COPD), asthma, infectious processes, and malignancies. Specific management of these diagnoses is beyond the scope of this guideline.

93. **Evaluate for Observation or Admission**

    Disposition decisions are largely dependent on the patient's stability. The initial treatment must be directed toward treating any instability and searching for the etiology of the symptoms. Pulse, blood pressure, respirations, and level of consciousness must be assessed. Other factors that need to be considered are age, general state of health and immunocompetency, and reliability. If a patient is labile or unstable, or at risk of becoming unstable, admit the patient *[R]*.

94. **Symptoms and Signs Suggest Chest Wall/Costochondritis?**

    Costochondritis and intercostal strain frequently presents with chest pain. Typically, the patient is able to localize the discomfort to a fairly limited area. Physical examination should reveal reproducible pain at the site of the discomfort.

95. **Non-Steroidal Anti-Inflammatory Drugs/Thermal Application/Follow-Up As Needed**

    Once the clinician has determined that the chest discomfort is limited to the chest wall, treatment with nonsteroidal anti-inflammatory medication should be started and the patient should be advised on local application. Follow-up may be arranged as needed. For expanded discussion, refer to the National Guideline Clearinghouse (NGC) summary of the Institute for Clinical Systems Improvement (ICSI) guideline Assessment and Management of Acute Pain. *[R]*

96. **Consider Gastrointestinal Diagnosis?**

    Gastrointestinal disorders are sometimes perceived by the patient as chest pain. Once the clinician is confident that no intra-thoracic processes are the cause of the discomfort, a gastrointestinal diagnosis should be considered.

97. **Gastrointestinal Evaluation**

    Commonly history, physical examination, and a laboratory evaluation will suggest a gastrointestinal diagnosis. Further evaluation of this is beyond the scope of this guideline.

98. **Reconsider Differential Diagnosis**

    If the clinician, after initial evaluation and work-up, does not arrive at a likely working diagnosis, he/she may have to go back and reconsider the entire differential diagnosis a second time in order to make certain that no serious condition has been missed. The clinician may then have to redirect his/her search for a diagnosis to conditions of the thoracic spine and thoracic nerves. Other considerations are somatization and anxiety disorders. These may be more or less obvious after careful consideration. For anxiety diagnoses, refer to the NGC summary of the ICSI guideline Major Depression in Adults in Primary Care.

    Differential diagnoses of thoracic spine and thoracic neuralgias include metastatic malignancy, multiple myeloma, arthritic processes, ankylosing spondylitis, osteomyelitis, kyphoscoliosis, and herpes zoster.

    Atypical chest pain associated with mitral valve prolapse is a poorly understood symptom *[R]*.

Clinic Evaluation Algorithm Annotations

100. **Initial Focused Assessment for High-Risk History, Physical Examination, and Other Findings**

History should include characterization of pain, exacerbating or relieving factors, associated symptoms, and risk factors for coronary disease. Physical examination should include careful cardiovascular and pulmonary examination, peripheral vascular examination, and evaluation for hypertension and hypercholesterolemia. Lab studies may include resting electrocardiogram, chest x-ray, hemoglobin, and others if clinically indicated *[C]*.

The patient's description of pain and the history of previous coronary disease are by far the most important parts of the history.

Carotid bruits, peripheral vascular disease, and xanthomas on physical examination suggest a higher likelihood of coronary disease. The resting electrocardiogram may show evidence of previous infarction.

Direct provider education toward completing the history evaluation.

High-risk symptoms on initial presentation include:

History

- Severe or ongoing pain
- Pain lasting 20 minutes or more
- New pain at rest or with minimal activity
- Severe dyspnea
- Loss of consciousness

Physical Findings

- Hypotension or other signs of underperfusion
- Tachycardia or bradycardia
- Pulmonary edema, cyanosis

Electrocardiogram Findings

- ST elevation greater than 1 mm on two contiguous leads suggesting acute myocardial infarction
- New ST or T wave changes
- ST depression greater than 1 mm at rest
- New left bundle branch block

102. **Initiate Emergency Interventions and Transfer to Emergency Department as Appropriate**

Initiate emergency intervention as appropriate and transfer the patient as soon as possible for further emergency intervention.

A patient complaining of chest pain should immediately be placed on a cardiac monitor. Vital signs should be taken, intravenous access started, oxygen administered, and immediate electrocardiogram taken. Institution of stabilizing therapy (including nitroglycerin and chewable aspirin for suspect anginal pain) prior to the completion of the history or physical is appropriate and often necessary at this level *[R].*

103. **Coronary Artery Disease Diagnosis Secure?**

When the clinical setting and history suggest typical angina pectoris (substernal pain provoked by exertion and relieved by nitroglycerin or rest), the physician is very likely correct in assuming an ischemic coronary syndrome. Treatment and prognostic evaluation may proceed as outlined in the NGC summary of the ICSI guideline Stable Coronary Artery Disease.

104. **Refer to the NGC summary of the ICSI guideline Stable Coronary Artery Disease**

Typical angina pectoris, if stable for 60 days and without evidence of recent myocardial infarction, may be treated under the NGC summary of the ICSI guideline Stable Coronary Artery Disease.

105. **Ischemic Heart Pain Possible?**

When coronary disease is of intermediate probability, a stress test may contribute supplemental information. When coronary disease is unlikely based on highly atypical symptoms and low prevalence of coronary disease among the population to which the patient belongs, stress testing may be misleading.

106. **Choose Stress Test/Cardiology Referral Optional**

Choose the best type of cardiac stress test based on:

- The resting cardiogram
- The patient's ability to walk
- Local expertise

107. **Can Patient Walk?**

In patients who cannot exercise, consider pharmacologic stress and imaging test (with adenosine, dipyridamole, or dobutamine). Physical exercise is the most physiologic form of cardiovascular stress. If one doubts how far a patient will be able to walk, it might still be worthwhile to attempt treadmill exercise. The occasional patient with orthopedic restriction may be able to perform bicycle ergometry *[R]*.

109. **Resting Electrocardiogram Interpretable?**

Marked resting electrocardiogram abnormalities, such as left bundle branch block, left ventricular hypertrophy with repolarization abnormality, ventricular pre-excitation, or ventricular paced rhythm, render the exercise

electrocardiogram uninterpretable for ischemic changes. Patients on digoxin and those with less than 1 mm resting ST depression may undergo standard electrocardiogram stress testing, provided the clinician realizes that further ST depression with exercise has minimal diagnostic significance. A stable abnormality with exercise is reassuring *[C]*, *[R]*.

110. **Do Exercise Imaging Study**

When the resting electrocardiogram is markedly abnormal, use an exercise imaging test (stress echocardiogram, stress radionuclear perfusion, stress radionuclear ventriculogram) *[R]*.

111. **Do Regular Treadmill Stress Test**

Use the Bruce protocol, modified if need be for debilitated patients. Adequacy of exercise and myocardial challenge is generally accepted as achieving greater than or equal to 85% of age-predicted maximum heart rate. The Bruce protocol, because of extensive use and long-term follow-up, provides the most reliable prognostic information *[R]*.

112. **Is Test Strongly Positive?**

Stress testing may be strongly positive and suggest a moderate to high risk of cardiovascular events as indicated by the Duke treadmill score, which is based upon the Bruce protocol.

A stress test predicts the patient's prognosis and provides evidence of the presence or absence of coronary artery disease. Of these two types of information, the first, establishing the patient's prognosis, is the more reliable.

Treadmill findings which signify a poor prognosis are:

- Poor exercise tolerance
- Hypotension
- Marked ST abnormality at a low work load

Conversely, good exercise tolerance to a high heart rate and blood pressure signifies a good prognosis, even if the exercise electrocardiogram is somewhat abnormal. (For example, a patient who walks nine minutes and has 1 mm of asymptomatic ST depression.)

Mark et al. (Duke treadmill score) validated an easy-to-use treadmill score which stratifies high-, intermediate-, and low-risk patients. The Duke treadmill score was developed from a retrospective study of 2,842 inpatients. It was prospectively tested on an outpatient population of 613 patients with an endpoint of patient mortality. Consequently, it is well validated and the best measurement for the prognostic interpretation of treadmill tests.

A Duke score of greater than or equal to five is generally accepted as a passing score, and such patients may be discharged to home with follow-up within 72 hours.

[A], *[B]*, *[C]*, *[R]*

113. **Is Patient a Candidate for Revascularization?**

Unless advanced age, comorbidity, or patient preference suggests medical treatment, high-risk patients should be considered for revascularization. Patients identified as high risk by treadmill testing often have left ventricular dysfunction, left main coronary stenosis, or other serious coronary disease. Revascularization may offer a better prognosis *[A]*, *[C]*.

116. **Is Test Positive but Low Risk?**

A stress cardiogram may be positive but without features that signify a poor prognosis as noted above. For example, a 65-year-old man with atypical angina and 1.0 mm ST depression at 10 minutes has a good prognosis even though he has coronary disease.

117. **Is Diagnostic Certainty Adequate?**

A positive test may confirm the clinical diagnosis of coronary disease and allow treatment as outlined under the NGC summary of the ICSI guideline Stable Coronary Artery Disease. *[M]*

Refer to cardiology if diagnostic certainty is critical.

120. **Is Test Equivocal?**

Because of resting abnormality, limited exercise performance, limited heart rate, or minor exercise abnormalities, the test may not be clearly normal or abnormal, yet high-risk treadmill findings are absent *[C]*, *[M]*.

121. **Is Diagnostic Certainty Adequate?**

Knowing that the patient is not at high risk may suggest empiric treatment or non-cardiac evaluation. Refer to cardiology if diagnostic certainty is important *[C]*, *[M]*.

124. **Test is Normal**

A normal test may confirm the clinical impression of non-cardiac symptoms. Refer to cardiology if symptoms are worrisome despite a normal stress test.

Compared with the prognostic information contained in a stress test, the diagnostic information is more variable. The physician must consider:

1. How to estimate the pre-test likelihood of coronary disease based upon the patient's age, sex, and description of chest pain. If pretest likelihood is very high or very low, a test of intermediate predictive value, such as treadmill stress testing, may be misleading *[M]*.
2. How abnormal are the exercise findings?

   Greater than 1 mm flat or 1.5 mm upsloping ST depression measured 80 msec. after the J point occurring with a normal resting electrocardiogram is considered a positive test. However, "positive" is not all-or-nothing. Downsloping ST depression, greater degrees of ST depression, persistent ST depression, and ST depression at a low work load are "more positive." Conversely, upsloping ST depression, ST depression at a high work load, and rapidly-resolving ST depression are "less positive."

3. How good is the test itself? Is exercise challenge adequate, heart rate high enough? Resting abnormality present?
4. The natural history of a coronary plaque. A non-obstructive plaque may become active, provoke unstable symptoms by platelet emboli or vasoconstriction, yet not impair exercise coronary flow. **A normal test isn't reassuring if the symptoms are worrisome.**
5. What is the diagnostic goal? Absolute certainty for airline pilots? Reasonable reassurance?

Despite the complexities of interpretation, stress testing is a valuable tool in the evaluation of a patient with chest pain. Clinical judgment is paramount.

[C], *[M]*

Definitions:

Classes of Research Reports:

A. Primary Reports of New Data Collection:

Class A:

- Randomized, controlled trial

Class B:

- Cohort study

Class C:

- Non-randomized trial with concurrent or historical controls
- Case-control study
- Study of sensitivity and specificity of a diagnostic test
- Population-based descriptive study

Class D:

- Cross-sectional study
- Case series
- Case report

B. Reports that Synthesize or Reflect upon Collections of Primary Reports:

Class M:

- Meta-analysis
- Systematic review
- Decision analysis
- Cost-effectiveness analysis

Class R:

- Consensus statement
- Consensus report
- Narrative review

Class X:

- Medical opinion

CLINICAL ALGORITHM(S)

Detailed and annotated clinical algorithms are provided for:

- Chest Pain Screening
- Emergency Intervention
- ST-Segment Elevation Myocardial Infarction (STEMI)
- Acute Myocardial Infarction Complications
- Special Work-Up
- Non-Cardiac Causes
- Clinic Evaluation

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is classified for selected recommendations (see "Major Recommendations").

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Successful emergency interventions for patients with high-risk chest pain
- Minimized delay in administering thrombolytics or angioplasty to patients with acute myocardial infarction

- Timely initiation of treatment to reduce post-infarction mortality in patients with acute myocardial infarction
- Appropriate tobacco use assessment and cessation counseling and treatment for patients with acute myocardial infarction
- Appropriate use of cardiac rehabilitation post-discharge

POTENTIAL HARMS

Adverse Effects of Medications and Precautions

- The recently completed SYNERGY study found increased adverse events in patients that were switched from *unfractionated heparin* to *enoxaparin* or vice-versa at the time of referral to tertiary care institutions. Therefore, the suggestion is that the patient be started and maintained on one drug or the other during transfer and treatment at referring and referral institutions.
- *Enoxaparin* should be used with caution in patients with renal insufficiency.
- Caution in administering intravenous *beta-blocker* is advised until after revascularization and stabilization of the patient's blood pressure. Intravenous beta-blocker should be avoided in Killip III/IV patients
- *Calcium channel blockers* should be avoided in patients with decreased left ventricular function or heart failure. The short-acting dihydropyridine *calcium channel blockers* (e.g., *nifedipine*) may be associated with increased risk and should be avoided in acute ischemic syndromes.
- Low patient weight has been identified as an ongoing risk factor for significant intracranial hemorrhage when *thrombolytics* are administered.
- Use of non-steroidal anti-inflammatory drugs and cyclooxygenase-2 (COX-2) inhibitors may reduce the cardioprotective benefits of aspirin.

CONTRAINDICATIONS

CONTRAINDICATIONS

Contraindications to Glycoprotein IIb/IIIa Inhibitors

- Bleeding less than 6 weeks
- Intracranial hemorrhage (ever)
- Recent stroke less than two years
- Uncontrolled hypertension greater than 200/100 mmHg
- Surgery less than six weeks
- Aortic dissection
- Acute pericarditis
- Platelets less than 100,000 mm^3
- Dialysis dependent renal failure

Contraindications to Nitroglycerin

- Hypotension
- Documented severe aortic stenosis
- Hypertrophic cardiomyopathy
- Sildenafil, vardenafil, or tadalafil within the previous 24 hours or tadalafil in the previous 48 hours

Contraindications to Beta-blockers

Absolute Contraindication

- ST-elevation myocardial infarction due to cocaine use
- Cardiogenic shock

Relative Contraindications

- Asthma
- First degree of atrioventricular block
- Hypotension
- Heart rate less than 60/min
- Decompensated congested heart failure

Contraindications to Thrombolytics*

Absolute Contraindications

- Previous hemorrhagic stroke at any time; other strokes or cerebrovascular events within one year
- Known intracranial neoplasm
- Active internal bleeding (does not include menses)
- Suspected aortic dissection

Cautions/Relative Contraindications

- Severe uncontrolled hypertension on presentation (greater than 180/110 mm Hg)**
- History of prior cerebrovascular accident or known intracerebral pathology not covered in above absolute contraindications
- Current use of anticoagulants in therapeutic doses (international normalized ratio greater than or equal to 2.0 to 3.0); known bleeding diathesis
- Recent trauma (including head trauma) within 2 to 4 weeks
- Major surgery in past 3 to 6 months
- Noncompressible vascular punctures
- Recent internal bleeding
- For streptokinase/anistreplase: prior exposure (especially within five days to two years) or prior allergic reaction
- Pregnancy
- Active peptic ulcer
- History of chronic hypertension

* Advisory only. May not be all inclusive or definitive. Patients with relative contraindications should be evaluated on a case-by-case basis. Percutaneous coronary intervention (PCI) may provide equal or increased benefit at decreased risk.

**Severe uncontrolled hypertension on presentation is a relative contraindication. Even if hypertension is brought under control, patients subsequently treated with thrombolytics experience increased rates of intracranial hemorrhage (ICH) compared to patients who are normotensive on presentation. Arrange for primary PCI in high-risk hypertensive patients if feasible.

NOTE: Cardiopulmonary resuscitation performed for less than 10 minutes is NOT a contraindication.

QUALIFYING STATEMENTS

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- These clinical guidelines are designed to assist-clinicians by providing an analytical framework for the evaluation and treatment of patients, and are not intended either to replace a clinician's judgment or to establish a protocol for all patients with a particular condition. A guideline will rarely establish the only approach to a problem.
- This medical guideline should not be construed as medical advice or medical opinion related to any specific facts or circumstances. Patients are urged to consult a health care professional regarding their own situation and any specific medical questions they may have.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

Once a guideline is approved for general implementation, a medical group can choose to concentrate on the implementation of that guideline. When four or more groups choose the same guideline to implement and they wish to collaborate with others, they may form an action group.

In the action group, each medical group sets specific goals they plan to achieve in improving patient care based on the particular guideline(s). Each medical group shares its experiences and supporting measurement results within the action group. This sharing facilitates a collaborative learning environment. Action group learnings are also documented and shared with interested medical groups within the collaborative.

Currently, action groups may focus on one guideline or a set of guidelines such as hypertension, lipid treatment, and tobacco cessation.

Detailed measurement strategies are presented in the original guideline document to help close the gap between clinical practice and the guideline recommendations. Summaries of the measures are provided in the National Quality Measures Clearinghouse (NQMC).

Key Implementation Recommendations

The following system changes were identified by the guideline work group as key strategies for health care systems to incorporate in support of the implementation of this guideline.

1. Clinics should have a process in place for a patient to be referred for emergency intervention via 911, or be seen in the clinic the same day, within 72 hours, or as an elective clinic evaluation based upon the presence of high-risk symptoms and duration.
2. Hospitals should develop and implement emergency room critical pathways and consider standard orders to accomplish rapid evaluation and treatment of

acute coronary syndrome. Standard discharge orders/ instructions should also be considered.

3. A process should be in place for the patient and family that will rapidly orient them to the suspected diagnosis, emergency room and Critical Care Unit (CCU) process and other treatment measures to be considered. This could include both caregiver face-to-face interactions with the patient and family as well as teaching tools in written form.
4. Institutions that cannot meet the recommended treatment times for primary percutaneous coronary intervention should consider the preferential use of intravenous thrombolytic therapy. These institutions should have a predetermined plan for treating patients who present with contraindications to thrombolytics. Such plans may employ delayed local primary percutaneous coronary intervention or transfer to another institution.

IMPLEMENTATION TOOLS

Clinical Algorithm
Pocket Guide/Reference Cards
Quality Measures
Resources

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

RELATED NQMC MEASURES

- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of patients with chest pain symptoms in the emergency department receiving early therapy including intravenous access, oxygen, nitroglycerin, morphine and a chewable aspirin on arrival.
- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of patients with acute myocardial infarction (AMI) receiving thrombolytics with a "door-to-drug time" (time from presentation to administration of drug) of less than 30 minutes.
- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of patients with acute myocardial infarction (AMI) receiving beta-blockers within 24 hours of arrival and on discharge.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness
Timeliness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Institute for Clinical Systems Improvement (ICSI). Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2008 Oct. 69 p. [138 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

2004 Nov (revised 2008 Oct)

GUIDELINE DEVELOPER(S)

Institute for Clinical Systems Improvement - Private Nonprofit Organization

GUIDELINE DEVELOPER COMMENT

Organizations participating in the Institute for Clinical Systems Improvement (ICSI): Affiliated Community Medical Centers, Allina Medical Clinic, Altru Health System, Aspen Medical Group, Avera Health, CentraCare, Columbia Park Medical Group, Community-University Health Care Center, Dakota Clinic, ENT Specialty Care, Fairview Health Services, Family HealthServices Minnesota, Family Practice Medical Center, Gateway Family Health Clinic, Gillette Children's Specialty Healthcare, Grand Itasca Clinic and Hospital, HealthEast Care System, HealthPartners Central Minnesota Clinics, HealthPartners Medical Group and Clinics, Hutchinson Area Health Care, Hutchinson Medical Center, Lakeview Clinic, Mayo Clinic, Mercy Hospital and Health Care Center, MeritCare, Mille Lacs Health System, Minnesota Gastroenterology, Montevideo Clinic, North Clinic, North Memorial Care System, North Suburban Family Physicians, Northwest Family Physicians, Olmsted Medical Center, Park Nicollet Health Services, Pilot City Health Center, Quello Clinic, Ridgeview Medical Center, River Falls Medical Clinic, Saint Mary's/Duluth Clinic Health System, St. Paul Heart Clinic, Sioux Valley Hospitals and Health System, Southside Community Health Services, Stillwater Medical Group, SuperiorHealth Medical Group, University of Minnesota Physicians, Winona Clinic, Ltd., Winona Health

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GUIDELINE COMMITTEE

Cardiovascular Steering Committee

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Work Group Members: R. Scott Wright, MD (Work Group Leader) (Mayo Clinic) (Cardiology); Paul Spilde, PT (Park Nicollet Health Services) (Cardiac Rehabilitation); James Morrison, MD (HealthPartners Medical Group) (Cardiology); M. Danish Rizvi, MD (HealthPartners Medical Group) (Cardiology); Jackson Thatcher, MD (Park Nicollet Health Services) (Cardiology); Editha Liu, MD (Avera Health) (Hospitalist); Tonja Larson, PharmD, BCPS (Marshfield Clinic) (Pharmacy); Kathy Melsha, PharmD, BCPS (Park Nicollet Health Services) (Pharmacy); Myounghee Hanson (Institute for Clinical Systems Improvement) (Facilitator); Teresa Hunteman (Institute for Clinical Systems Improvement) (Measurement/Implementation Advisor)

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ICSI has adopted a policy of transparency, disclosing potential conflict and competing interests of all individuals who participate in the development, revision and approval of ICSI documents (guidelines, order sets and protocols). This applies to all work groups (guidelines, order sets and protocols) and committees (Committee on Evidence-Based Practice, Cardiovascular Steering Committee, Women's Health Steering Committee, Preventive & Health Maintenance Steering Committee and Respiratory Steering Committee).

Participants must disclose any potential conflict and competing interests they or their dependents (spouse, dependent children, or others claimed as dependents) may have with any organization with commercial, proprietary, or political interests relevant to the topics covered by ICSI documents. Such disclosures will be shared with all individuals who prepare, review and approve ICSI documents.

R. Scott Wright, MD is a consultant for and receives research/grant funding from Hoffman LaRoche pertaining to clinical trial testing of Dalcetrapib.

No other work group members have potential conflicts of interest to disclose.

ICSI's conflict of interest policy and procedures are available for review on ICSI's website at www.icsi.org.

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2006 Oct. 76 p.

GUIDELINE AVAILABILITY

Electronic copies: Available from the Institute for Clinical Systems Improvement (ICSI) Web site.

Print copies: Available from ICSI, 8009 34th Avenue South, Suite 1200, Bloomington, MN 55425; telephone, (952) 814-7060; fax, (952) 858-9675; Web site: www.icsi.org; e-mail: icsi.info@icsi.org.

AVAILABILITY OF COMPANION DOCUMENTS

The following are available:

- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Executive summary. Bloomington (MN): Institute for Clinical Systems Improvement, 2008 Oct. 1 p. Electronic copies: Available from the Institute for Clinical Systems Improvement (ICSI) Web site.
- ICSI pocket guidelines. May 2007 edition. Bloomington (MN): Institute for Clinical Systems Improvement, 2007.

Print copies: Available from ICSI, 8009 34th Avenue South, Suite 1200, Bloomington, MN 55425; telephone, (952) 814-7060; fax, (952) 858-9675; Web site: www.icsi.org; e-mail: icsi.info@icsi.org.

PATIENT RESOURCES

None available

NGC STATUS

This NGC summary was completed by ECRI on February 16, 2005. This summary was updated on May 3, 2005 following the withdrawal of Bextra (valdecoxib) from the market and the release of heightened warnings for Celebrex (celecoxib) and other nonselective nonsteroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on June 16, 2005, following the U.S. Food and Drug Administration advisory on COX-2 selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs). This NGC summary was updated by ECRI on January 12, 2006 and February 1, 2007. This summary was updated by ECRI on March 6, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin sodium). This summary was updated by ECRI Institute on June 22, 2007 following the U.S. Food and Drug Administration (FDA) advisory on heparin sodium injection. This summary was updated by ECRI Institute on July 12, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Troponin-1 Immunoassay. This summary was updated by ECRI Institute on September 7, 2007 following the revised U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin). This summary was updated by ECRI Institute on November 9, 2007, following the U.S. Food and Drug Administration advisory on Antidepressant drugs. This summary was updated by ECRI Institute on March 14, 2008 following the updated FDA advisory on heparin sodium injection. This NGC summary was updated by ECRI Institute on April 15, 2009.

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